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METHOD OF PREVENTING CELL DEATH USING SEGMENTS OF NEURAL THREAD PROTEINS

This application claims priority to U.S. Provisional Patent Application No. 60/290,971, entitled: "Method of Preventing Cell Death Using Segment of Neural Thread Proteins," the disclosure of which is incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to methods for preventing cell death, and to methods of treating conditions that require prevention, inhibition, and/or amelioration of cell death and tissue necrosis. The invention encompasses administering a segment of neural thread proteins (NTP), or a homologue, derivative, variant or mimetic thereof, to a mammal experiencing cell death. The segment can be administered intramuscularly, orally, intravenously, intraperitoneally, intracerebrally (intraparenchymally), intracerebroventricularly, intratumorally, intralesionally, intradermally, intrathecally, intranasally, intraocularly, intraarterially, topically, transdermally, via an aerosol, infusion, bolus injection, implantation device, sustained release system etc., either alone or conjugated to a carrier. Alternatively, the segment can be expressed *in vivo* by administering a gene that expresses the segment, by administering a vaccine that induces such production or by introducing cells, bacteria or viruses that express the segment *in vivo*, either because of genetic modification or otherwise.

2. Description of Related Art

Alzheimer's disease (AD) is a complex neurodegenerative disorder characterized by progressive impairments in memory, behavior, language, and visuo-spatial skills, ending ultimately in death. Hallmark pathologies within vulnerable regions include extracellular β -amyloid deposits, intracellular

neurofibrillary tangles, synaptic loss, and extensive neuronal cell death. Research on the causes and treatments of Alzheimer's disease has led investigators down numerous avenues. Considerable evidence has implicated alterations in production or processing of the human amyloid precursor protein (APP) in the etiology of the disease. However, intensive research has proven that AD is a multifactorial disease with many different, perhaps overlapping, etiologies.

Because of this, those in the field have conducted significant research and clinical investigations to study the structural deficiencies, chemical changes, and functional abnormalities both within the brain and within different populations of nerve cells. The depth of such investigations and studies are represented by the following publications, which represent only a handful of the vast reports in this arena: *Neurobiology of Alzheimer's Disease* (D. Dawbarn and S. J. Allen, Editors), Bios, Oxford 1995; *Dementia*, (J. Whitehouse, Ed.), F.A. Davis Company, Philadelphia, 1993; *Alzheimer's Disease: Senile Dementia and Related Disorders* (Katzman, R, and R. L. Bick, Eds), Raven Press, New York, 1994, pages 47-51; *Alzheimer's Disease and Related Disorders, Etiology, Pathogenesis and Therapeutics* (Iqbol, K., et al., Eds.), Wiley, Chichester, 1999; *Alzheimer's Disease: Advances in Clinical and Basic Research* (Corain, B, Ed.), Wiley, New York, 1993; *Alzheimer's Disease: Clinical and Treatment Perspectives* (Cutler, N.R., et al., Eds.), Wiley, Chichester, 1995; *Alzheimer's Disease: Therapeutic Strategies* (Giacobini, E., Becker, R., Eds.), Birkhauser, Boston, 1994; Paykel, et al., *Arch. Gen. Psychiat.*, **51**:325-332 (1994); Amaducci, et al., *Neurology*, **36**:922-931 (1986); McKhann, et al., *Neurology* **34**:939-944 (1984), Heston et al., *Arch. Gen. Psychiatry* **38**:1085-1090 (1981); *Aging of the Brain* (Gispen and Traber, editors), Elsevier Science Publishers, Amsterdam, 1983, pages 275-282; Heyman et al., *Ann. Neurol* **15**:335-341 (1984); Brayne C. and P. Calloway, *Lancet* **1**:1265-1267 (1988); Roth et al., *Br. J. Psychiatry* **149**:698-709 (1986); Medical Research Council, *Report from the NRC Alzheimer's Disease Workshop*, London, England, 1987; Morris et al., *Neurology* **41**:469-478 (1991); and the references cited within each of these publications.

To date, Alzheimer's disease is the third most expensive disease in the United States, costing society approximately \$100 billion each year. It is one of the most prevalent illnesses in the elderly population, and with the aging of society, will become even more significant. Costs associated with AD include
5 direct medical costs such as nursing home care, direct non-medical costs such as in-home day care, and indirect costs such as lost patient and care giver productivity. Medical treatment and behavior modification may have economic benefits by slowing the rate of cognitive decline, delaying institutionalization, reducing care giver hours, and improving quality of life. Pharmacoeconomic
10 evaluations have shown positive results regarding the effect of drug therapy and behavior modification on nursing home placement, cognition, and care giver time.

Neural thread proteins (NTP) are a family of recently characterized brain proteins. One member of this family, AD7C-NTP, is a ~41 kD membrane associated phosphoprotein with functions related to neuritic sprouting (de la
15 Monte *et al.*, *J. Clin. Invest.*, 100:3093-3104 (1997); de la Monte *et al.*, *Alz.. Rep.*, 2:327-332 (1999); de la Monte SM and Wands JR, *Journal of Alzheimer's Disease*, 3:345-353 (2001)). The gene that encodes AD7C-NTP and predicted protein sequence for AD7C-NTP has been identified and described (de la Monte
et al., *J. Clin. Invest.*, 100:3093-3104 (1997)). In addition to the ~41 kD species,
20 other species of neural thread protein (~26 kD, ~21 kD, ~17 kD, and ~15 kD) have been identified and associated with neuroectodermal tumors, astrocytomas, and glioblastomas and with injury due to hypoxia, schema, or cerebral infarction (Xu *et al.*, *Cancer Research*, 53:3823-3829 (1993); de la Monte *et al.*, *J. Neuropathol. Exp. Neurol.*, 55(10):1038-50 (1996), de la Monte *et al.*, *J. Neurol. Sci.*, 138(1-2):26-35 (1996); de la Monte *et al.*, *J. Neurol. Sci.*, 135(2):118-25 (1996); de la Monte *et al.*, *J. Clin. Invest.*, 100:3093-3104 (1997); and de la
25 Monte *et al.*, *Alz.. Rep.*, 2:327-332 (1999)).

Species of neural thread protein have been described and claimed in U.S. Patent Nos. 5,948,634; 5,948,888; and 5,830,670, all for "Neural Thread Protein
30 Gene Expression and Detection of Alzheimer's Disease" and in U.S. Patent No. 6,071,705 for "Method of Detecting Neurological Disease or Dysfunction." The

disclosures of these patents are specifically incorporated herein by reference in their entirety. As described therein, NTP is upregulated and produced during cell death. Thus, dead and dying nerve cells are described as overproducing NTP, and accordingly, its presence indicates the death of nerve cells and the onset of

5 Alzheimer's disease (AD).

Other species of neural thread protein have been identified as other products of the AD7c-NTP gene (*e.g.* a 112 amino acid protein described in NCBI Entrez-Protein database Accession #XP_032307 PID g15928971) or as being similar to neural thread proteins (*e.g.* a 106 amino acid protein described in NCBI

10 Entrez-Protein database Accession #AAH14951 PID g15928971, another 106 amino acid protein described in NCBI Entrez-Protein database Accession #XP_039102 PID g18599339 and a 61 amino acid protein described in NCBI Entrez-Protein database Accession #AAH02534 PID g12803421).

There is compelling evidence linking the AD7C-NTP specie of neural

15 thread protein in particular with AD and its upregulation during cell death in AD. AD7C-NTP mRNA is upregulated in AD brain compared to controls; AD7C-NTP protein levels in brain and in CSF are higher in AD than controls; and AD7C-NTP immunoreactivity is found in senile plaques, in neurofibrillary tangles (NFT), in degenerating neurons, neuropil threads, and dystrophic neurotic sprouts in AD and

20 Down syndrome brains (Ozturk *et al.*, *Proc. Natl. Acad. Sci. USA*, 86:419-423 (1989); de la Monte *et al.*, *J. Clin. Invest.*, 86(3):1004-13 (1990); de la Monte *et al.*, *J. Neurol. Sci.*, 113(2):152-64 (1992); de la Monte *et al.*, *Ann. Neurol.*, 32(6):733-42 (1992); de la Monte *et al.*, *J. Neuropathol. Exp. Neurol.*, 55(10):1038-50 (1996), de la Monte *et al.*, *J. Neurol. Sci.*, 138(1-2):26-35 (1996);

25 de la Monte *et al.*, *J. Neurol. Sci.*, 135(2):118-25 (1996); de la Monte *et al.*, *J. Clin. Invest.*, 100:3093-3104 (1997); and de la Monte *et al.*, *Alz. Rep.*, 2:327-332 (1999)). Immunocytochemistry demonstrated that the AD7C-NTP protein is localized within cells, within fine processes within the neuropil, or is extracellular in both AD and Down's Syndrome brains. de la Monte *et al.*, *Ann. Neurol.*,

30 32(6):733-42 (1992). Two types of cells contain AD7C-NTP: neurons and

astrocytes (*Id.*). The affected neurons are the large pyramidal type that typically contain the neurofibrillary tangles well known in AD brain (*Id.*).

Elevated levels of AD7C-NTP protein have been found in both CSF and urine of AD patients, showing its accuracy as a biochemical marker for this
5 devastating illness (de la Monte and Wands, *Front Biosci* 7: 989-96 (2002); de la Monte and Wands, *Journal of Alzheimer's Disease* 3: 345-353 (2001); Munzar *et al*, *Alzheimer's Reports* 4: 61-65 (2001); Kahle *et al*, *Neurology* 54: 1498-1504 (2000) and Averbach *Neurology* 55: 1068 (2000); Munzar *et al*, *Alzheimer Reports* 3: 155-159 (2000); de la Monte *et al*, *Alzheimer's Reports* 2: 327-332
10 (1999); Ghanbari *et al*, *J Clin Lab Anal* 12: 285-288 (1998); Ghanbari *et al*, *J Clin Lab Anal* 12: 223-226 (1998); Ghanbari *et al*, *Journal of Contemporary Neurology* 1998; 4A: 2-6 (1998); and de la Monte *et al*, *J Clin Invest* 100: 3093-3104 (1997).

Over-expression of the AD7C-NTP gene also has been linked to the
15 process of cell death in Alzheimer's disease (de la Monte and Wands, *J. Neuropathol. and Exp. Neuro.*, 60:195-207 (2001); de la Monte and Wands, *Cell Mol Life Sci* 58: 844-49 (2001). AD7C-NTP has also been identified in Down's Syndrome brain tissue (Wands *et al.*, International Patent Publication No. WO 90/06993; de la Monte *et al*, *J Neurol Sci* 135: 118-25 (1996); de la Monte *et al.*,
20 *Alz. Rep.*, 2:327-332 (1999)). There is some evidence that over-expression of the AD7C-NTP gene also may be associated with normal tension glaucoma (Golubnitschaja-Labudova *et al*, *Curr Eye Res* 21: 867-76 (2000)).

The present inventor recently discovered that released AD7C-NTP protein was cytotoxic and capable of causing cell death to other cells in tissue (as
25 compared with up-regulated AD7C-NTP produced by the dying cell itself), as disclosed in pending United States patent application Serial No. _____ and entitled "Methods of Treating Tumors and Related Conditions Using Neural Thread Proteins," the disclosure of which is incorporated by reference herein in its entirety. Accordingly, it would be desirable to prevent, inhibit, modulate or
30 ameliorate cell death and tissue necrosis associated with neural thread proteins, especially in AD brain.

It has also recently been discovered that segments of NTP could be used in binding assays, purification of NTP, and as diagnostics as a substitute for NTP, as disclosed in pending United States patent application serial No. 09/697,590 and entitled: "Preferred Segments of Neural Thread Protein and Methods of Using the
5 Same," the disclosure of which is incorporated by reference herein in its entirety.

Throughout this description, including the foregoing description of related art, any and all publicly available documents described herein, including any and all U.S. patents, are specifically incorporated by reference herein in their entirety. The foregoing description of related art is not intended in any way as an
10 admission that any of the documents described therein, including pending United States patent applications, are prior art to the present invention.

SUMMARY OF THE INVENTION

There exists a need to develop a method of preventing, inhibiting, modulating and/or ameliorating cell death and tissue necrosis. In particular, there
15 exists a need to develop a method capable of preventing, inhibiting and/or ameliorating cell death and/or tissue necrosis in the brain. There also exists a need to develop a method of treating conditions associated with cell death and/or tissue necrosis. There also exists a need to develop a method of treating neurodegenerative disorders such as AD by preventing, inhibiting and/or
20 ameliorating cell death and/or tissue necrosis in live mammalian brain tissue. There also exists a need to develop a method of controlling, inhibiting, modulating or ameliorating cell death and tissue necrosis in live tissue caused by NTP administered in order to remove or destroy harmful or unwanted tissue or cellular elements such as benign or malignant tumors in humans.

25 It is therefore a feature of an embodiment of the invention to provide a method of preventing, inhibiting and/or ameliorating cell death and/or tissue necrosis. The method includes contacting the live tissue with at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof), whereby the segment is present in an amount sufficient to prevent, inhibit, reduce, control
30 and/or ameliorate cell death and/or tissue necrosis.

In accordance with another feature of an embodiment of the invention, there is provided a method of preventing, inhibiting and/or ameliorating cell death and/or tissue necrosis in live mammalian brain tissue by contacting the live mammalian brain tissue with a component containing at least one segment
5 of NTP (or a homologue, derivative, variant or mimetic thereof) that is present in an amount sufficient to prevent, inhibit, and/or ameliorate cell death and/or tissue necrosis. The component is capable of crossing the blood-brain barrier.

In accordance with another feature of an embodiment of the invention, there is provided a method of treating neurodegenerative disorders by contacting
10 live mammalian brain tissue with a component containing at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof). The component is capable of crossing the blood-brain barrier.

In accordance with yet another feature of an embodiment of the invention, there is provided a method of treating conditions associated with cell death
15 and/or tissue necrosis comprising contacting live tissue with at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof). The segment of NTP is present in an amount sufficient to prevent and/or inhibit cell death and/or tissue necrosis. In accordance with this method, at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof) is administered to a mammal
20 having a condition associated with cell death and/or tissue necrosis in an amount sufficient to prevent and/or inhibit cell death and/or tissue necrosis.

In accordance with another feature of an embodiment of the invention, there is provided a composition comprising at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof) and a component that enables
25 the segment of NTP (or a homologue, derivative, variant or mimetic thereof) to cross the blood-brain barrier.

In accordance with yet another feature of an embodiment of the invention, there is provided a method of treating conditions associated with cell death and/or tissue necrosis comprising administering a gene to a mammal in need thereof,
30 whereby the gene expresses at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof), and whereby the administration results in

the segment of NTP (or a homologue, derivative, variant or mimetic thereof) contacting live tissue. The gene is administered in such a fashion that the segment of NTP (or a homologue, derivative, variant or mimetic thereof) is present in an amount sufficient to prevent and/or inhibit cell death and/or tissue necrosis.

5 In accordance with an additional feature of an embodiment of the invention, there is provided a method of treating conditions associated with cell death and/or tissue necrosis comprising administering a vaccine to a mammal in need thereof, whereby the vaccine induces the mammal to express or otherwise produce at least one segment of NTP (or a homologue, derivative, variant or
10 mimetic thereof), and whereby the administration results in the at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof) contacting live tissue. The vaccine is administered in such a fashion that the at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof) is present in an amount sufficient to prevent and/or inhibit cell death and/or tissue
15 necrosis.

 In accordance with yet another feature of an embodiment of the invention, there is provided a method of treating conditions associated with cell death and/or tissue necrosis comprising introducing or administering to or implanting in a mammal in need thereof cells, bacteria or viruses that are capable of expressing *in*
20 *vivo* at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof), whereby the cells, bacteria or viruses express at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof), and whereby the administration results in at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof) contacting live tissue. The cells, bacteria or viruses
25 are introduced, administered or implanted in such a fashion and in such a quantity that at least one segment of NTP (or a homologue, derivative, variant or mimetic thereof) is present in an amount sufficient to prevent, inhibit and/or ameliorate cell death and/or tissue necrosis.

 These and other features of the invention will be readily apparent to those
30 skilled in the art upon reading the detailed description that follows. It should be understood, however, that the detailed description and the specific examples,

while indicating preferred embodiments of the invention are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this description. Unless otherwise specified, the respective contents of the documents
5 cited herein are hereby incorporated by reference in their entirety.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the complete AD7C-NTP sequence and the location of the Harlil sequences within the complete AD7C-NTP sequence (de la Monte et al., *J.*
10 *Neuropathol. Exp. Neurol.*, 55:1038-1050 (1996)).

Figure 2 shows the complete amino acid sequences of the 122 amino acid neural thread protein (Sequence 40 from U.S. Patent No. 5,948,634; NCBI Entrez-Protein Accession #AAE25447).

15 Figure 3 shows the complete amino acid sequences of the 112 amino acid neural thread protein (NCBI Entrez-Protein Accession #XP_032307).

Figure 4 shows the 106 amino acid neural thread protein listed in NCBI Entrez-Protein Accession # AAH14951 PID g15928971.

20 Figure 5 shows the 106 amino acid neural thread protein listed in NCBI Entrez-Protein Accession # XP_039102, PID g18599339.

Figure 6 shows the complete amino acid sequences of the 98 amino acid neural thread protein (Sequence 30 from U.S. Patent No. 5,830,670; NCBI Entrez-Protein Accession #AAE13612).

25 Figure 7 shows the complete amino acid sequences of the 75 amino acid neural thread protein (Sequence 48 from U.S. Patent No. 5,948,634; NCBI Entrez-Protein Accession #AAE25448).

Figure 8 shows the complete amino acid sequences of the 68 amino acid neural thread protein (Sequence 36 from U.S. Patent No. 5,948,634; NCBI Entrez-Protein Accession #AAE25446).

Figure 9 shows the complete amino acid sequences of the 61 amino acid
5 neural thread protein-like protein (NCBI Entrez-Protein Accession #AAH02534).

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The term "AD7C-NTP" refers to the ~41kD protein and the gene and the nucleic acid sequences coding for it described in de la Monte et al., *J. Clin.*
10 *Invest.*, 100:3093-104 (1997), in Sequences 120 and 121 of U.S. Patent Nos. 5,948,634, 5,948,888, and 5,830,670 and in NCBI Entrez-Protein database Accession #AF010144.

Throughout this description, the term "NTP" or "neural thread protein" refers to neural thread proteins and related molecules (including pancreatic thread
15 protein) and the nucleic acid sequences coding for those proteins, and includes (but is not limited to) the following proteins and the nucleic acid sequences encoding the amino acid sequences for these proteins:

- (a) AD7C-NTP;
- (b) the ~42, ~26, ~21, ~17, ~14, and ~8 kD species of neural thread
20 protein as described in U.S. Patent Nos. 5,948,634, 5,948,888, 5,830,670, and 6,071,705 and in de la Monte *et al.*, *J. Neuropathol. Exp. Neurol.*, 55(10):1038-50 (1996), de la Monte *et al.*, *J. Neurol. Sci.*, 138(1-2):26-35 (1996); de la Monte *et al.*, *J. Neurol. Sci.*, 135(2):118-25 (1996), de la Monte *et al.*, *J. Clin. Invest.*, 100:3093-3104 (1997) and de la Monte *et al.*, *Alz. Rep.*, 2:327-332 (1999);
25
- (c) proteins specifically recognized by monoclonal antibody #2 on deposit with the American Type Culture Collection, Manassas, Va., under accession number HB-12546 or monoclonal antibody

#5 on deposit with the American Type Culture Collection,
Manassas, Va., under accession number HB-12545;

- 5 (d) proteins coded by the AD7C-NTP gene;
- (e) the 122 amino acid neural thread protein described in Sequence
40 from U.S. Patent Nos. 5,830,670, 5,948,634, and 5,948,888
and listed in NCBI Entrez-Protein Accession #AAE25447, PID
g10048540, the amino acid sequences for which is illustrated in
Figure 2;
- 10 (f) the 112 amino acid neural thread protein listed in NCBI Entrez-
Protein Accession #XP_032307, PID g14725132, the amino acid
sequences for which is illustrated in Figure 3;
- (g) a 106 amino acid neural thread protein-like protein listed in
NCBI Entrez-Protein Accession #AAH14951 PID g15928971,
the amino acid sequences for which is illustrated in Figure 4;
- 15 (h) a 106 amino acid neural thread protein-like protein listed in NCBI
Entrez-Protein Accession #XP_039102, PID g18599339, the
amino acid sequences for which is illustrated in Figure 5;
- (i) the 98 amino acid neural thread protein described in Sequence 30
from U.S. Patent Nos. 5,830,670, 5,948,634, and 5,948,888 and
20 listed in NCBI Entrez-Protein Accession # AAE13612, PID
g10048538, the amino acid sequences for which is illustrated in
Figure 6;
- (j) the 75 amino acid neural thread protein described in Sequence 48
from U.S. Patent Nos. 5,830,670, 5,948,634, and 5,948,888 and
25 listed in NCBI Entrez-Protein Accession #AAE25448, PID
g10048541, the amino acid sequences for which is illustrated in
Figure 7;
- (k) the 68 amino acid neural thread protein described in Sequence 36
from U.S. Patent Nos. 5,830,670, 5,948,634, and 5,948,888 and
30 listed in NCBI Entrez-Protein Accession #AAE25446, PID

g10048539, the amino acid sequences for which is illustrated in Figure 8;

- (l) the 61 amino acid neural thread protein-like protein listed in NCBI Entrez-Protein Accession #AAH02534, PID g12803421, the amino acid sequences for which is illustrated in Figure 9;
- (m) pancreatic thread protein;
- (n) the neural pancreatic thread protein (nPTP) described in U.S. Patent No. 6,071,705; and
- (o) proteins specifically recognized by the antibodies produced by a hybridoma from the group consisting of HB 9934, HB 9935, and HB 9936 deposited at the American Type Culture Collection.

The term "NTP" also includes NTP derived from mammalian tissue or produced using recombinant techniques and includes fragments, variants, derivatives, and homologues of NTP.

Amino acids and amino acid residues described herein may be referred to according to the accepted one or three-letter code provided in the table below. Unless otherwise specified, these amino acids or residues are of the naturally occurring L stereoisomer form.

Table 1

20	Amino Acid	One-Letter Symbol	Three-Letter Symbol
	Alanine	A	Ala
	Arginine	R	Arg
	Asparagine	N	Asn
25	Aspartic acid	D	Asp
	Cysteine	C	Cys
	Glutamine	Q	Gln
	Glutamic acid	E	Glu
	Glycine	G	Gly
30	Histidine	H	His
	Isoleucine	I	Ile
	Leucine	L	Leu
	Lysine	K	Lys
	Methionine	M	Met

	Phenylalanine	F	Phe
	Proline	P	Pro
	Serine	S	Ser
	Threonine	T	Thr
5	Tryptophan	W	Trp
	Tyrosine	Y	Tyr
	Valine	V	Val

As used herein, the term or "Harlil sequence" or "Harlil peptide" refers to
 10 a biologically active peptide that comprises or contains one or more of the
 following sequences:

1. THARLIL; HHARLCL; MFARLIL; and HHARLIF
 as described in Figure 1;
2. HHARL; HARL; HARLI; HARLIL; HHARLCL; ARL
 15 IL; HHARLIF; THARLIL; ARLI; ARL; HARLCL; ARLCL;
 ARCL; MFARLIL; FARLIL; FARLI; FARL; HARLIF; and ARLIF;
3. LHARLCLANFCGRNRV ("NTP-1");
4. LARLCLANFCGNNNV ("NTP-2");
- 20 5. CARYRTGHHARLM ("NTP-3");
6. HHARLPLANFCG ("NTP-4");
7. RTGHHARLCLANFC ("NTP-5");
8. CESARYRTGHHARLC ("NTP-6");
9. DNTHHARLIL ("NTP-7");
- 25 10. SHHARLIL ("NTP-8"); and
11. HARLML, HARLV L and HAKLIL

The term "Harlil sequence" or "Harlil peptide" as it is used herein also
 includes biologically active variants, homologues, derivatives and peptide
 mimetics of Harlil sequences or Harlil peptides and includes biologically active
 30 peptides containing the sequence of any of the sequences listed in subparagraphs 1
 to 11 above with additional amino acid residues before or after the Harlil
 sequence on linker peptides.

As used herein, the term "segment of NTP" refers to a biologically active fragment of a species of NTP, preferably AD7C-NTP, and specifically includes (but is not limited to) Harlil sequences and Harlil peptides.

5 The term "biologically active" refers to a protein, peptide, Harlil peptide, or segment of NTP that has the ability of binding to NTP or other molecules.

The term "fragment" refers to a protein or polypeptide that consists of a continuous subsequence of the amino acid sequence of a NTP protein or segment of NTP and includes naturally occurring fragments such as splice variants and fragments resulting from naturally occurring *in vivo* protease activity. Such a
10 fragment may be truncated at the amino terminus, the carboxy terminus, and/or internally (such as by natural splicing). Such fragments may be prepared with or without an amino terminal methionine. The term "fragment" includes fragments, whether identical or different, from the same NTP protein or segment of NTP, with a contiguous amino acid sequence in common or not, joined together, either
15 directly or through a linker.

The term "variant" refers to a protein or polypeptide in which one or more amino acid substitutions, deletions, and/or insertions are present as compared to the amino acid sequence of an NTP protein or segment of NTP and includes naturally occurring allelic variants or alternative splice variants of an NTP protein
20 or segment of NTP. The term "variant" includes the replacement of one or more amino acids in a peptide sequence with a similar or homologous amino acid(s) or a dissimilar amino acid(s). There are many scales on which amino acids can be ranked as similar or homologous. (Gunnar von Heijne, *Sequence Analysis in Molecular Biology*, p. 123-39 (Academic Press, New York, NY 1987.) Preferred
25 variants include alanine substitutions at one or more of amino acid positions. Other preferred substitutions include conservative substitutions that have little or no effect on the overall net charge, polarity, or hydrophobicity of the protein. Conservative substitutions are set forth in Table 2 below.

TABLE 2

Conservative Amino Acid Substitutions

5	Basic:	arginine
		lysine
		histidine
	Acidic:	glutamic acid
		aspartic acid
10	Uncharged Polar:	glutamine
		asparagine
		serine
		threonine
		tyrosine
15	Non-Polar:	phenylalanine
		tryptophan
		cysteine
		glycine
		alanine
20		valine
		proline
		methionine
		leucine
		isoleucine

Table 3 sets out another scheme of amino acid substitution:

TABLE 3

	Original Residue	Substitutions
5	Ala	gly; ser
	Arg	lys
	Asn	gln; his
	Asp	glu
10	Cys	ser
	Gln	asn
	Glu	asp
	Gly	ala; pro
	His	asn; gln
15	Ile	leu; val
	Leu	ile; val
	Lys	arg; gln; glu
	Met	leu; tyr; ile
	Phe	met; leu; tyr
20	Ser	thr
	Thr	ser
	Trp	tyr
	Tyr	trp; phe
	Val	ile; leu
25		

Other variants can consist of less conservative amino acid substitutions, such as selecting residues that differ more significantly in their effect on maintaining (a) the structure of the polypeptide backbone in the area of the substitution, for example, as a sheet or helical conformation, (b) the charge or hydrophobicity of the molecule at the target site, or (c) the bulk of the side chain. The substitutions that in general are expected to have a more significant effect on function are those in which (a) glycine and/or proline is substituted by another amino acid or is deleted or inserted; (b) a hydrophilic residue, e.g., seryl or threonyl, is substituted for (or by) a hydrophobic residue, e.g., leucyl, isoleucyl, phenylalanyl, valyl, or alanyl; (c) a cysteine residue is substituted for (or by) any other residue; (d) a residue having an electropositive side chain, e.g., lysyl, arginyl, or histidyl, is substituted for (or by) a residue having an electronegative charge, e.g., glutamyl or aspartyl; or (e) a residue having a bulky side chain, e.g.,

phenylalanine, is substituted for (or by) one not having such a side chain, e.g., glycine. Other variants include those designed to either generate a novel glycosylation and/or phosphorylation site(s), or those designed to delete an existing glycosylation and/or phosphorylation site(s). Variants include at least
5 one amino acid substitution at a glycosylation site, a proteolytic cleavage site and/or a cysteine residue. Variants also include NTP proteins or segments of NTP with additional amino acid residues before or after the NTP or segment of NTP amino acid sequence on linker peptides. For example, a cysteine residue may be added at both the amino and carboxy terminals of a segment of NTP in order to
10 allow the cyclisation of the segment of NTP by the formation of a di-sulphide bond. The term "variant" also encompasses polypeptides that have the amino acid sequence of a Harlil peptide with at least one and up to 25 additional amino acids flanking either the 3' or 5' end of the Harlil peptide.

The term "derivative" refers to a chemically modified protein or
15 polypeptide that has been chemically modified either by natural processes, such as processing and other post-translational modifications, but also by chemical modification techniques, as for example, by addition of one or more polyethylene glycol molecules, sugars, phosphates, and/or other such molecules, where the molecule or molecules are not naturally attached to wild-type NTP proteins or
20 segments. Derivatives include salts. Such chemical modifications are well described in basic texts and in more detailed monographs, as well as in a voluminous research literature, and they are well known to those of skill in the art. It will be appreciated that the same type of modification may be present in the same or varying degree at several sites in a given protein or polypeptide. Also, a
25 given protein or polypeptide may contain many types of modifications. Modifications can occur anywhere in a protein or polypeptide, including the peptide backbone, the amino acid side-chains, and the amino or carboxyl termini. Modifications include, for example, acetylation, acylation, ADP-ribosylation, amidation, covalent attachment of flavin, covalent attachment of a heme moiety,
30 covalent attachment of a nucleotide or nucleotide derivative, covalent attachment of a lipid or lipid derivative, covalent attachment of phosphatidylinositol, cross-

linking, cyclization, disulfide bond formation, demethylation, formation of covalent cross-links, formation of cysteine, formation of pyroglutamate, formylation, gamma-carboxylation, glycosylation, GPI anchor formation, hydroxylation, iodination, methylation, myristoylation, oxidation, proteolytic
5 processing, phosphorylation, prenylation, racemization, glycosylation, lipid attachment, sulfation, gamma-carboxylation of glutamic acid residues, hydroxylation and ADP-ribosylation, selenoylation, sulfation, transfer-RNA mediated addition of amino acids to proteins, such as arginylation, and ubiquitination. See, for instance, *Proteins--Structure And Molecular Properties*,
10 2nd Ed., T. E. Creighton, W. H. Freeman and Company, New York (1993) and Wold, F., "Posttranslational Protein Modifications: Perspectives and Prospects," pgs. 1-12 in *Posttranslational Covalent Modification Of Proteins*, B. C. Johnson, Ed., Academic Press, New York (1983); Seifter et al., *Meth. Enzymol.* 182:626-646 (1990) and Rattan et al., "Protein Synthesis: Posttranslational Modifications
15 and Aging," *Ann. N.Y. Acad. Sci.* 663: 48-62 (1992). The term "derivatives" include chemical modifications resulting in the protein or polypeptide becoming branched or cyclic, with or without branching. Cyclic, branched and branched circular proteins or polypeptides may result from post-translational natural processes and may be made by entirely synthetic methods, as well.

20 The term "homologue" refers to a protein that is at least 75 percent identical in its amino acid sequence of an NTP protein, AD7C-NTP or a segment of NTP, as the case may be, as determined by standard methods that are commonly used to compare the similarity in position of the amino acids of two polypeptides. The degree of similarity or identity between two proteins can be
25 readily calculated by known methods, including but not limited to those described in *Computational Molecular Biology*, Lesk, A. M., ed., Oxford University Press, New York, 1988; *Biocomputing: Informatics and Genome Projects*, Smith, D. W., ed., Academic Press, New York, 1993; *Computer Analysis of Sequence Data*, Part I, Griffin, A. M., and Griffin, H. G., eds., Humana Press, New Jersey, 1994;
30 *Sequence Analysis in Molecular Biology*, von Heinje, G., Academic Press, 1987; *Sequence Analysis Primer*, Gribskov, M. and Devereux, J., eds., M Stockton

Press, New York, 1991; and Carillo H. and Lipman, D., SIAM, *J. Applied Math.*, 48: 1073 (1988). Preferred methods to determine identity are designed to give the largest match between the sequences tested. Methods to determine identity and similarity are codified in publicly available computer programs.

5 Preferred computer program methods useful in determining the identity and similarity between two sequences include, but are not limited to, the GCG program package (Devereux, J., *et al.*, *Nucleic Acids Research*, 12(1): 387 (1984)), BLASTP, BLASTN, and FASTA, Atschul, S. F. *et al.*, *J. Molec. Biol.*, 215: 403-410 (1990). The **BLAST** X program is publicly available from NCBI
10 and other sources (**BLAST** Manual, Altschul, S., *et al.*, NCBI NLM NIH Bethesda, Md. 20894; Altschul, S., *et al.*, *J. Mol. Biol.*, 215: 403-410 (1990). By way of example, using a computer algorithm such as GAP (Genetic Computer Group, University of Wisconsin, Madison, Wis.), the two proteins or polypeptides for which the percent sequence identity is to be determined are aligned for optimal
15 matching of their respective amino acids (the "matched span", as determined by the algorithm).

A gap opening penalty (which is calculated as 3 x (times) the average diagonal; the "average diagonal" is the average of the diagonal of the comparison matrix being used; the "diagonal" is the score or number assigned to each perfect
20 amino acid by the particular comparison matrix) and a gap extension penalty (which is usually 1/10 times the gap opening penalty), as well as a comparison matrix such as PAM 250 or BLOSUM 62 are used in conjunction with the algorithm. A standard comparison matrix (*see* Dayhoff *et al.* in: *Atlas of Protein Sequence and Structure*, vol. 5, supp.3 [1978] for the PAM250 comparison
25 matrix; *see* Henikoff *et al.*, *Proc. Natl. Acad. Sci USA*, 89:10915-10919 [1992] for the BLOSUM 62 comparison matrix) also may be used by the algorithm. The percent identity then is calculated by the algorithm. Homologues will typically have one or more amino acid substitutions, deletions, and/or insertions as compared with NTP, AD7c-NTP, a segment of NTP, or Harlil sequence.

30 The term "peptide mimetic" or "mimetic" refers to biologically active compounds that mimic the biological activity of a peptide or a protein but are no

longer peptidic in chemical nature, that is, they no longer contain any peptide bonds (that is, amide bonds between amino acids). Here, the term peptide mimetic is used in a broader sense to include molecules that are no longer completely peptidic in nature, such as pseudo-peptides, semi-peptides and
5 peptoids. Examples of peptide mimetics in this broader sense (where part of a peptide is replaced by a structure lacking peptide bonds) are described below. Whether completely or partially non-peptide, peptide mimetics according to this invention provide a spatial arrangement of reactive chemical moieties that closely resemble the three-dimensional arrangement of active groups in the antibody,
10 antibody derivative or antibody fragment on which the peptide mimetic is based. As a result of this similar active-site geometry, the peptide mimetic has effects on biological systems that are similar to the biological activity of the peptide.

The peptide mimetics of this invention are preferably substantially similar in both three-dimensional shape and biological activity to the segments of NTP
15 described herein. Examples of methods of structurally modifying a peptide known in the art to create a peptide mimetic include the inversion of backbone chiral centers leading to D-amino acid residue structures that may, particularly at the N-terminus, lead to enhanced stability for proteolytical degradation without adversely affecting activity. An example is given in the paper "Tritiated D-ala¹ -
20 Peptide T Binding", Smith C. S. *et al.*, *Drug Development Res.*, 15, pp. 371-379 (1988). A second method is altering cyclic structure for stability, such as N to C interchain imides and lactames (Ede *et al.* in Smith and Rivier (Eds.) "Peptides: Chemistry and Biology", Escom, Leiden (1991), pp. 268-270). An example of this is given in conformationally restricted thymopentin-like compounds, such as
25 those disclosed in U.S. Pat. No. 4,457,489 (1985), Goldstein, G. *et al.*, the disclosure of which is incorporated by reference herein in its entirety. A third method is to substitute peptide bonds in the segment of NTP by pseudopeptide bonds that confer resistance to proteolysis.

A number of pseudopeptide bonds have been described that in general do
30 not affect peptide structure and biological activity. One example of this approach is to substitute retro-inverso pseudopeptide bonds ("Biologically active

retroinverso analogues of thymopentin”, Sisto A. *et al* in Rivier, J. E. and Marshall, G. R. (eds) “Peptides, Chemistry, Structure and Biology”, *Escom, Leiden* (1990), pp. 722-773) and Dalpozzo, *et al.* (1993), *Int. J. Peptide Protein Res.*, 41:561-566, incorporated herein by reference). According to this

5 modification, the amino acid sequences of the peptides may be identical to the sequences of a segment of NTP described above, except that one or more of the peptide bonds are replaced by a retro-inverso pseudopeptide bond. Preferably the most N-terminal peptide bond is substituted, since such a substitution will confer resistance to proteolysis by exopeptidases acting on the N-terminus. Further
10 modifications also can be made by replacing chemical groups of the amino acids with other chemical groups of similar structure. Another suitable pseudopeptide bond that is known to enhance stability to enzymatic cleavage with no or little loss of biological activity is the reduced isostere pseudopeptide bond is a (Couder, *et al.* (1993), *Int. J. Peptide Protein Res.*, 41:181-184, incorporated herein by
15 reference in its entirety).

Thus, the amino acid sequences of these peptides may be identical to the sequences of a segment of NTP or Harlil sequence, except that one or more of the peptide bonds are replaced by an isostere pseudopeptide bond. Preferably the most N-terminal peptide bond is substituted, since such a substitution would
20 confer resistance to proteolysis by exopeptidases acting on the N-terminus. The synthesis of peptides with one or more reduced isostere pseudopeptide bonds is known in the art (Couder, *et al.* (1993), cited above). Other examples include the introduction of ketomethylene or methylsulfide bonds to replace peptide bonds.

Peptoid derivatives of segments of NTP or Harlil sequence represent
25 another class of peptide mimetics that retain the important structural determinants for biological activity, yet eliminate the peptide bonds, thereby conferring resistance to proteolysis (Simon, *et al.*, 1992, *Proc. Natl. Acad. Sci. USA*, 89:9367-9371, incorporated herein by reference in its entirety). Peptoids are oligomers of N-substituted glycines. A number of N-alkyl groups have been
30 described, each corresponding to the side chain of a natural amino acid (Simon, *et al.* (1992), cited above). Some or all of the amino acids of the segment of NTP or

Harlil sequence may be replaced with the N-substituted glycine corresponding to the replaced amino acid.

The term "peptide mimetic" or "mimetic" also includes reverse-D peptides and enantiomers as defined below.

5 The term "reverse-D peptide" refers to a biologically active protein or peptide consisting of D-amino acids arranged in a reverse order as compared to the L-amino acid sequence of a segment of NTP or Harlil sequence. Thus, the carboxy terminal residue of an L-amino acid segment of NTP becomes the amino terminal for the D-amino acid peptide and so forth. For example, the AD7c-NTP
10 fragment, HARLIL, becomes L_dI_dL_dR_dA_dH_d, where A_d, H_d, I_d, L_d, and R_d are the D-amino acids corresponding to the L-amino acids, A, H, I, L, and R respectively.

The term "enantiomer" refers to a biologically active protein or peptide where one or more the L-amino acid residues in the amino acid sequence of a segment of NTP is replaced with the corresponding D-amino acid residue(s).

15 Throughout this description, the term "neurodegenerative disorder" refers to:

1. pathological conditions characterized by one or more of the following signs: brain atrophy, cell loss, neurofibrillary tangles, amyloid plaques, and/or the presence of NTP in tissue and/or bodily fluids;
- 20 2. the Alzheimer group of diseases, namely, Alzheimer's disease (pre-senile dementia, senile dementia); Alzheimer's disease associated with Down's syndrome; familial Alzheimer's Disease; genetic Alzheimer's disease due to mutations such as Presenilin 1, Presenilin 2, and others; Alzheimer's disease associated with other central-nervous-system
25 diseases, such as Parkinson's disease, Lewy Body Disease, and cerebrovascular diseases;
3. congophilic angiopathy (associated or not associated with Alzheimer's disease, familial or not familial);
4. pathological conditions characterized by the deposition of abnormal
30 fibrils ("amyloid fibrils") and/or related non-fibrillar amyloid precursor or non-precursor molecule(s);

5. pathological conditions characterized by the abnormal deposition of tau including frontotemporal dementia, progressive supranuclear palsy (PSP), corticobasal ganglionic degeneration (CBD) and conditions relating to mutations of the tau gene; and/or
- 5 6. other disorders and diseases such as those disclosed in U.S. Patent No. 6,001,331, the disclosure of which is incorporated by reference herein in its entirety.

Throughout this description, the expressions “amyloid plaques” and “amyloid fibrils” denote senile plaques, neuritic plaques, amyloid plaques, amyloid stars, amyloid cores, primitive plaques, classical plaques, burn out
10 plaques, diffuse plaques, shadow plaques, neurofibrillary tangles, amyloid fibrils, paired helical filaments, and the like.

Throughout this description, the term “mammal” denotes all mammals, and preferably denotes, sheep, cows, dogs, cats, apes, monkeys, mice, rats, and
15 humans, and most preferably denotes a human.

Throughout this description, the expressions “segment of NTP,” “Harlil sequence” and “Harlil peptide” are used interchangeably. It is to be understood that, whenever “segment of NTP,” “Harlil sequence” or “Harlil peptide” is used, the invention encompasses suitable homologues, variants, derivatives and peptic
20 mimetics thereof.

Throughout this description, the expression “tissue containing NTP” denotes tissue containing all or a portion of NTP, tissue in cellular communication with NTP that may or may not otherwise contain it, tissue that has been contacted with NTP, but no longer contains it in its original form, and tissue that may at
25 some point in time be in contact with NTP.

The present invention is directed toward methods of preventing cell death and/or tissue necrosis. While NTP has been known and described in the literature, it was not heretofore known that NTP was a cause of cell death of cells other than the cells producing the NTP. While not intending on being bound by any theory,
30 the present inventor believes that the presence of NTP in live tissue not only is an indication of certain nerve cell death, as previously reported, but it also is toxic

insofar as it causes other live tissue cell death. The present inventor believes that AD7C-NTP in particular present in live mammalian brain tissue is a marker for Alzheimer's Disease (AD), and it exacerbates AD by causing cell death and/or tissue necrosis in the live tissue in which it exists.

5 Accordingly, it is believed that, as a mammal becomes inflicted with AD, nerve cell death up-regulates the gene that preferably produces AD7C-NTP, thereby producing AD7C-NTP at that site. The AD7C-NTP so produced then begins destroying other live tissue (e.g., other nerve cells, glial cells, etc.) in the vicinity thereof, thereby exacerbating the progression of the disease. The inventor
10 therefore believes that neutralizing the effect of, for example, AD7C-NTP will help prevent, inhibit, and/or ameliorate cell death and/or tissue necrosis in live tissue that contains, for example, AD7C-NTP. It was surprising to find that segments of NTP could bind to the AD7C-NTP and prevent, inhibit, and/or ameliorate cell death and/or tissue necrosis in live tissue that contains AD7C-
15 NTP.

 NTP is known and described in, for example, U.S. Patent Nos. 5,948,634, 5,948,888, 5,830,670, and 6,071,705, the disclosures of which are incorporated by reference herein in their entirety. Methods of making NTP recombinantly or otherwise are disclosed in the aforementioned documents. Raising antibodies
20 against NTP so that one can diagnose AD and other associated disorders and diseases, also is disclosed in these documents. It will be evident to those skilled in the art that one may use NTP homologues, derivatives, mimetics and variants, as well as NTP from diverse sources (e.g., natural, pancreatic, purified, synthesized, or from different expression systems *in vitro*, etc.) to make any of the
25 segments useful in the present invention.

 The present invention is directed to a method of preventing and/or inhibiting cell death and/or tissue necrosis. The method includes contacting live tissue with at least one segment of NTP, whereby the segment is present in an amount sufficient to prevent and/or inhibit cell death and/or tissue necrosis. The
30 segment of NTP preferably is a subsequence of AD7C-NTP and most preferably contains at least one of the following repeat sequences of AD7C-NTP:

(a)	45-51	T H A R L I L
(b)	90-96	H H A R L C L
(c)	263-269	M F A R L I L
(d)	291-297	H H A R L I F

5 See Figure 1.

The invention encompasses peptides having the sequence of any of regions (a), (b), (c), (d), or homologues, derivatives, variants and mimetics of these (including but not limited to "H A R L M L"). The Harlil peptides also can have additional amino acid residues before or after the Harlil sequence on linker
 10 peptides. The additional amino acid residues or linker peptides may be those found in the NTP sequence before and after the Harlil sequence. For example, the amino acid residues G I T G M C T occur before residue 46 and the amino acid residues Y F F L V occur after amino acid 51 in the NTP sequence. Thus, a Harlil peptide useful as a segment of NTP in the present invention can include the NTP
 15 peptide G I T G M C T H A R L I L Y F F L V. For the Harlil peptides recited in (b), (c), and (d), the additional amino acid residues preferably are those that flank the Harlil sequence in the NTP sequence. Preferably, the Harlil peptide having additional amino acid residues does not exceed 25 total amino acid residues in length.

20 The Harlil repeat sequence preferably has the unique characteristic of binding to NTP. This ability to bind to NTP suggests that the Harlil repeat sequence is useful in preventing, inhibiting or ameliorating cell death and/or tissue necrosis in live tissue containing NTP.

The present invention is directed to the use of Harlil sequence peptides and
 25 their homologues, derivatives, variants and peptide mimetics as affinity binding partners of NTP and other molecules for the treatment of conditions associated with cell death and/or tissue necrosis. The invention also is directed to methods of treating conditions associated with cell death and/or tissue necrosis as well as compositions containing Harlil peptides or their homologues, derivatives,
 30 variants, and peptide mimetics that are capable of crossing the bbb.

Harlil peptides and homologues, derivatives, and variants thereof can be made using conventional peptide synthesis techniques. Mimetics of Harlil peptides can be developed using combinatorial chemistry techniques.

5 Nucleic acids corresponding to Harlil peptides can be made, for example, using (a) standard recombinant methods, (b) synthetic techniques, or (c) combinations thereof.

Harlil sequences bind to AD7C-NTP and other molecules. See pending United States patent application serial No. 09/697,590 and entitled: "Preferred Segments of Neural Thread Protein and Methods of Using the Same," the
10 disclosure of which is incorporated by reference herein in its entirety.

This invention includes the surprising discovery that a Harlil sequence that can bind to AD7C-NTP can prevent or inhibit cell death and/or tissue necrosis in live tissue containing AD7C-NTP.

There is evidence that AD7C-NTP participates in the neurodegenerative
15 cascade. The ability to interrupt or redirect the cascade by targeting AD7C-NTP offers a therapeutic opportunity. For example, it may be possible to intervene therapeutically by using the ability of the Harlil peptides to interact with AD7C-NTP binding sites, thus blocking potential reactive sites on AD7C-NTP.

Alternatively, the Harlil peptides of the invention may be useful to target
20 drugs to cells expressing the Harlil sequence, or to create genes or vaccines that induce expression of the Harlil sequence *in vivo*.

Although the actual mechanism by which the Harlil sequence operates is not yet known, the present inventor has found that administration of a Harlil sequence to live tissue that contains AD7C-NTP prevents and/or inhibits and/or
25 ameliorates cell death and tissue necrosis that otherwise occurs in the absence of the Harlil sequence.

It is possible that the "HARLIL" sites interact with other brain proteins and may play a role in the functionality of AD7C-NTP and/or other NTP or other molecules.

30 Methods of making and detecting such Harlil sequences, or their functional homologues or analogues are described in copending United States

patent application serial No. 09/ 697,590, and entitled: "Preferred Segments of Neural Thread Protein and Methods of Using the Same," the disclosure of which is incorporated by reference herein in its entirety.

The peptide segments of NTP that are particularly useful in the context of the present invention are those described above that include at least a portion of the HARLIL amino acid sequence of AD7C-NTP. Useful Harlil sequences include those amino acid sequences selected from the following list:

- (a) H H A R L;
- (b) H A R L;
- 10 (c) H A R L I;
- (d) H A R L I L;
- (e) H H A R L C L;
- (f) A R L I L;
- (g) H H A R L I F;
- 15 (h) T H A R L I L;
- (i) A R L I;
- (j) A R L;
- (k) H A R L C L;
- (l) A R L C L;
- 20 (m) A R C L;
- (n) M F A R L I L;
- (o) F A R L I L;
- (p) F A R L I;
- (q) F A R L;
- 25 (r) H A R L I F;
- (s) A R L I F;

and homologues, variants, derivatives and mimetics thereof.

Various peptides selected from the above list, and homologues, variants, derivatives and mimetics thereof can be used in the present invention as the segment of NTP. For example, the peptide can have the amino acid sequence A R L I, and comprise at least one and up to 25 additional amino acids flanking either the 3' or 5' end of the peptide. The peptide also can have the amino acid

sequence H A R L, and comprise at least one and up to 25 additional amino acids flanking either the 3' or 5' end of the peptide. In addition, the peptide can have the amino acid sequence F A R L, and comprise at least one and up to 25 additional amino acids flanking either the 3' or 5' end of the peptide. The peptide
 5 also can be selected from one that has the amino acid sequence A R L, and comprising at least one and up to 25 additional amino acids flanking either the 3' or 5' end of the peptide. Yet another useful peptide in the present invention includes those having the amino acid sequence A R L C, and comprising at least one and up to 25 additional amino acids flanking either the 3' or 5' end of the
 10 peptide. Finally, the segment of NTP can be a polymer of a Harlil peptide sequence comprising at least two repetitions of the peptide.

It is even more preferred in the present invention that the Harlil sequences be peptides having the following amino acid sequences.

- | | | | |
|----|----|---------|---------------------------------|
| | 1. | (NTP-1) | L H A R L C L A N F C G R N R V |
| 15 | 2. | (NTP-2) | L A R L C L A N F C G N N N V |
| | 3. | (NTP-3) | C A R Y R T G H H A R L M |
| | 4. | (NTP-4) | H H A R L P L A N F C G |
| | 5. | (NTP-5) | R T G H H A R L C L A N F C |
| | 6. | (NTP-6) | C E S A R Y R T G H H A R L C |
| 20 | 7. | (NTP-7) | D N T H H A R L I L |
| | 8. | (NTP-8) | S H H A R L I L |

The above sequences can be conjugated to carrier proteins through a cysteine. Thus, peptides NTP-1 and NTP-2 produced mixed conjugate results due to the presence of more than one cysteine residue. Therefore, for peptides NTP-5
 25 and NTP-6, the secondary cysteine was blocked with Acetamido Methyl (C_3H_6NO) (ACM).

The location of the identified sequences in the AD7C-NTP can be seen from Figure 1. While all of the Harlil analogues showed some reactivity, particularly preferred Harlil analogs are those selected from NTP-1, NTP-3, and
 30 NTP-7. It should be noted that in the Harlil analog NTP-1, the first amino acid, "L" may be replaced with Lysine, or "K."

The Harlil sequences, or segments of NTP preferably are contacted with live tissue containing NTP. Any live tissue that contains NTP, that was contacted by NTP and the NTP no longer exists or does not exist in its original form, or that might at some point in time contain NTP is encompassed by the present invention.

5 Preferably, the tissue is tissue selected from mammalian tissue.

An embodiment of the invention includes a method of treating conditions caused by necrosis of live tissue containing NTP. In this context, the necrosis of live tissue and cell death denotes cell death and/or tissue necrosis of cells other than the dying cells that produce the NTP. In the method, a segment of NTP or a
10 Harlil sequence is administered to a mammal suffering from such a condition. The Harlil sequence is administered in an amount and for a period of time sufficient to prevent and/or inhibit the live tissue necrosis.

Those skilled in the art will appreciate that instead of directly administering the Harlil sequence, the Harlil sequence or homologue, variant,
15 derivative or mimetic thereof, can be produced or expressed by the mammal through gene expression (e.g., gene therapy) or through a vaccine. Skilled artisans are capable of creating, isolating and purifying suitable genes or vaccines useful in inducing expression of a Harlil sequence, or homologues, derivatives, variants or mimetics thereof, using the guidelines provided herein.

20 For example, gene therapy has attracted wide attention as a method to treat various mammalian diseases and enhance production of specific proteins or other cellular products. Gene therapy generally is accomplished by introducing exogenous genetic material into a mammalian patient's cells. The introduced genetic material can be designed to replace an abnormal (defective) gene of the
25 mammalian patient ("gene replacement therapy"), or can be designed for expression of the encoded protein or other therapeutic product without replacement of any defective gene ("gene augmentation"). Because many congenital and acquired medical disorders result from inadequate production of various gene products, gene therapy provides a means to treat these diseases
30 through either transient or stable expression of exogenous nucleic acid encoding the therapeutic product.

Gene therapy can be accomplished by either direct transformation of target cells within the mammalian subject (*in vivo* gene therapy) or transformation of cells *in vitro* and subsequent implantation of the transformed cells into the mammalian subject (*ex vivo* gene therapy). *In vivo* gene therapy is particularly
5 preferred for use in the present invention. In addition to repair of somatic cells, it is generally known that *in vivo* gene therapy also can be used for systemic treatment, an area in which gene therapy has broad applications. Systemic treatment involves transfecting target cells with the DNA of interest, expressing the coded protein in that cell, and the capability of the transformed cell to
10 subsequently secrete the manufactured protein into blood.

A variety of methods have been developed to accomplish *in vivo* transformation including mechanical means (e.g, direct injection of nucleic acid into target cells or particle bombardment), recombinant viruses, liposomes, and receptor-mediated endocytosis (RME) (for reviews, see Chang *et al.* 1994
15 *Gastroenterol.* 106:1076-84; Morsy *et al.* 1993 *JAMA* 270:2338-45; and Ledley 1992 *J. Pediatr. Gastroenterol. Nutr.* 14:328-37).

Suitable methods of developing and administering genes and vaccines suitable to induce *in vivo* expression of the Harlil sequences or segments of NTP, or homologues, variants, derivatives or mimetics thereof are disclosed in, for
20 example, U.S. Patent Nos. 6,210,919 and 6,225,290. The disclosures of each of these patents are incorporated by reference herein in their entirety.

Any condition associated with cell death and necrosis can be treated in accordance with the present invention. Preferably, the condition is selected from a neurodegenerative disease such as AD, Pick's Disease, Lewy body Disease, or
25 Parkinson's Disease, or from stroke, brain tumor, and other brain diseases, or glaucoma.

In accordance with preferred embodiments of the invention, the method includes contacting live tissue with at least one segment of NTP (or homologue, derivative, variant or mimetic thereof) in an amount sufficient to prevent cell
30 death and/or tissue necrosis. Methods of administering the segment of NTP include administering the segment of NTP intramuscularly, orally, intravenously,

intraperitoneally, intracerebrally (intraparenchymally), intracerebroventricularly, intratumorally, intralesionally, intradermally, intrathecally, intranasally, intraocularly, intraarterially, topically, transdermally, via an aerosol, infusion, bolus injection, implantation device, sustained release system etc., either alone or
5 conjugated to a carrier. In addition, the segment of NTP can be expressed or produced *in vivo* by administration of a gene that expresses the protein, by administration of a vaccine that induces such production, or by introduction of cells, bacteria or viruses that express the segment *in vivo*, as described above.

The treatment of nervous system disorders or other brain-related disorders
10 can be achieved by administering drugs that affect nervous system function or dysfunction in animals or patients. Typically, such drugs are administered by peripheral application, either via the oral or the systemic route. While some drugs are able to cross the blood brain barrier (bbb), others do not pass the bbb efficiently or not at all and are only effective when given directly into the brain.
15 The term "blood-brain barrier" or "bbb", as used herein, refers to the bbb proper as well as to the blood-spinal barrier. The blood-brain barrier, which consists of the endothelium of the brain vessels, the basal membrane and neuroglial cells, acts to limit penetration of substances into the brain. Sometimes the structure of the bbb is subdivided into two components: the endothelial or capillary barrier and the
20 ependymal barrier. Banks, W. A., Kastin, A. J., Barrera, "Delivering peptides to the central nervous system: Dilemmas and strategies," *Pharm. Res.* 8:1345-1350 (1991).

The nature of the substance penetration through the bbb has not yet been determined but it is known that many of the regulators of brain function such as
25 cytokines, transferrin, encephalins and endorphines can pass through the bbb from the blood vessels into the brain Raeissi, S., Audus, J., "In vitro characterization of blood-brain barrier permeability to delta sleep-inducing peptide." *J. Pharm. Phy.* 41:848-852(1989); Zlokovich, B., Susie, V. T., Davson, H. Begley, D. J., Jankov, R. M., Mitrovic, B. M., Lipovac, M. N., "Saturable mechanism for delta sleep-
30 inducing peptide (DSIP) at the blood-brain barrier of the vascularly perfused guinea pig brain." *Peptides* 10:249-254(1989); and Zlokovich, B., "In vivo

- approaches for studying peptide interaction at the blood-brain barrier." *J. Control. Rel.* 13:185-201(1990). However, many substances that can affect the Central Nervous System (or CNS) such as adenosine, β -endorphin, synthetic analogs of endogenous peptides Houghten, R. A. Swann, R. W., Li, C. H., " β -Endorphin: Stability, clearance behaviour and entry into the central nervous system after intravenous injection of the tritiated peptide in rats and rabbits." *Proc. Natl. Acad. Sci. USA* 77:4588-4591(1980); Levin, E. R., Frank, H. J. K., Weber, M. A., Ismail, M., Mills M., "Studies on penetration of the blood-brain barrier by atrial natriuretic factor." *Biochem. Biophys. Res. Commun.* 147:1226-1231(1987)
- 10 Sakane, T., Tanaka, C., Yamamoto, A., Hashida, M., Sesaki, H., Ueda, H., Takagi, H., "The effect of polysorbate 80 on brain uptake and analgesic effect of D-kyoto." *Int. J. Pharm.* 57:77-83(1989), as well as some excitatory and inhibitor amino acids and trophic factors, penetrate poorly or not at all through the bbb. At present, drugs with no bbb penetration or poor bbb penetration can only be given
- 15 by direct CNS infusion or by implantation of controlled-release polymers. (See, e.g., U.S. Pat. No. 4,883,666, Sabel *et al.*).

One way to overcome some of the limitations of traditional drug therapy is to increase the relative amount of drug that passes the bbb. The belief is that if one can increase the amount of the drug crossing the bbb while reducing the

20 peripheral dose of a given drug or diagnostic substance, the peripheral side effects of the drug are also less severe, while at the same time maintaining the desired effect in the brain. A number of approaches have been described as effective in increasing drug penetration through the bbb.

One approach has been to alter the function of the bbb itself. For instance,

25 osmotic agents, when given peripherally (such as by intravenous injection), result in the opening of the bbb. Further, some drugs acting on the CNS can change the permeability of the bbb for other substances; cholinomimetic arecolines, for instance, have been reported to induce changes of drug penetration through the bbb Saija, A., Princi, P., De Pasquale, R., Costa, G., "Arecoline but not

30 haloperidol produces changes in the permeability of the blood-brain barrier in the rat." *J. Pharm. Pha.* 42:135-138 (1990).

Other drugs that can be administered to alter the permeability of the bbb are disclosed in U.S. Pat. Nos. 5,059,415 and 5,124,146, both issued to E. A. Neuwelt. Bradykinin is one specific drug with such effects. (U.S. Pat. No. 5,112,596, issued to Malfroy-Camine). Another method comprises administering
5 permeabilizer peptides such as A-7 or conformational analogs thereof. (WO 92/18529, an application of J. W. Kozarich et al.). A relatively invasive method has been proposed by A. Tomasz and E. Tuomanen (WO 91/16064) who administer parenteral injections of purified cell wall or cell wall fragments of eubacteria such as *Streptococcus pneumoniae* to open the bbb.

10 U.S. Pat. No. 5,260,210 issued to L. L. Rubin *et al.*, discloses a method whereby the permeability of the blood-brain barrier is increased by administering an agent that reduces or interferes with cyclic AMP concentrations or that increases cyclic GMP concentrations.

Another approach is the modification of the drug molecules themselves.
15 For instance, macromolecules, such as proteins, do not pass the bbb at all, or pass through with difficulty or with alterations that adversely impact the proteins efficacy. For example, one can first isolate the macromolecule active site, *i.e.*, the portion of the molecule that triggers the biologically desirable event, and then use only this active site. Since size is one of the factors in allowing permeability of
20 the bbb, the reduced size can be used so that the smaller molecule can now pass the bbb. Other modifications to macromolecules to attempt passage of the bbb include glyrating the proteins, thereby enhancing their permeability of the bbb, or forming a prodrug. U.S. Pat. No. 5,260,308, issued to J. F. Podusio and G. L. Curran, discusses glyrating proteins, while U.S. Pat. No. 4,933,324 and WO
25 89/07938, both on applications of V. E. Shashoua, disclose formation of a prodrug. These prodrugs are formed from a fatty acid carrier and a neuroactive drug which is unable to pass across the bbb on its own. A similar system is disclosed in WO 89/07938.

30 Still another approach is the implantation of controlled release polymers that release the active ingredient from a matrix-system directly into the nervous tissue. However, this approach is invasive and requires surgical intervention if

implanted directly into the brain or spinal cord (see Sabel *et al.* U.S. Pat. No. 4,883,666; and Sabel *et al.* U.S. patent application Ser. No. 07/407,930). It also is known to administer compositions directly to internal portions of the brain, as disclosed on U.S. Pat. No. 5,800,390, the disclosure of which is incorporated by
5 reference herein in its entirety. These methods enable the delivery of sustained release, solid preparations and semi-solid preparations directly to brain tissue.

To overcome these limitations, another approach has been tried in which drug carrier systems are used such as liposomes, erythrocyte ghosts, antibody-conjugates, and monoclonal antibody conjugates. One of the major problems in
10 targeted drug delivery is the rapid opsonization and uptake of injected carriers by the reticuloendothelial system (RES), especially by the macrophages in the liver and spleen. This obstacle may be partially overcome in the case of liposomes by incorporation of so-called "stealth" lipids, such as phosphatidylinositol, monosialoganglioside, or sulfogalactosylceramide.

15 U.S. Pat. Nos. 5,182,107 and 5,154,924, both issued to P. M. Friden, teach a method of conjugating a drug with an antibody where the antibody is reactive with a transferrin receptor. Transferrin receptors are located on brain capillary endothelial cells, which thus can transport a drug, such as nerve growth factor, across the bbb. U.S. Pat. No. 5,004,697 (issued to Pardridge) improves such an
20 antibody-conjugate method by providing cationized antibodies with a specific isoelectric point (see also WO 89/01343 by Pardridge).

Another approach is to create chimeric peptides to which the active agents are conjugated (U.S. Pat. No. 4,801,575, also issued to Pardridge). Such a system is further discussed also in U.S. Pat. No. 4,902,505, issued to Pardridge and
25 Schimmel, in which the chimeric peptide, such as histone, is capable of crossing the bbb by transcytosis.

U.S. Pat. Nos. 5,187,158 and 5,017,566, both issued to N. S. Bodor, disclose a brain-specific drug delivery method wherein a centrally acting drug is given with the reduced, biooxidizable lipoidal form of a dihydropyridine reaction-
30 pyridine salt redox carrier such as dopamine. (See also U.S. Pat. No. 4,880,816, also issued to Bodor).

A rather invasive approach is taken to deliver genetic material to the brain. This is done, for example, by chemically disrupting the bbb and then using viruses to deliver genes across the bbb. (See, U.S. Pat. No. 4,866,042, issued to E. A. Neuwelt). Here, a corrective genetic material is incorporated into a virus and the virus is then injected into the bloodstream.

Finally, yet another carrier system to deliver drugs across the bbb is the use of liposomes, as disclosed by F. D. Collins and R. C. Thompson (WO 91/04014). Here, liposomes are targeted to specific endogenous brain transport systems that transport specific ligands across the bbb.

Another approach is disclosed in U.S. Patent No. 6,117,454, to Kreuter, *et al.* The subject matter of the Kreuter patent includes a method, composition and drug targeting system using surfactant coated nanoparticles as a drug carrier (or targeting molecule) for a wide range of drugs in order to enhance the penetration of drugs or diagnostic agents across the bbb.

Another approach is to administer the drugs intranasally, allowing for direct access to the brain and bypassing the bloodstream. This has been successfully done in an experimental model for three neuropeptides, melanocortin, vasopressin and insulin: Born J *et al.* "Sniffing neuropeptides: a transnasal approach to the human brain" *Nature Neuroscience* Advance online publication: 6 May 2002, DOI:10.1038/nn849.

Solid dosage forms for oral administration include capsules, tablets, pills, powders, and granules. In such solid dosage forms, the active compound usually is admixed with at least one of the following: (a) one or more inert excipients (or carrier), such as sodium citrate or dicalcium phosphate; (b) fillers or extenders, such as starches, lactose, sucrose, glucose, mannitol, and silicic acid; (c) binders, such as carboxymethylcellulose, alginates, gelatin, polyvinylpyrrolidone, sucrose and acacia; (d) humectants, such as glycerol; (e) disintegrating agents, such as agar-agar, calcium carbonate, potato or tapioca starch, alginic acid, certain complex silicates, and sodium carbonate; (f) solution retarders, such as paraffin; (g) absorption accelerators, such as quaternary ammonium compounds; (h) wetting agents, such as acetyl alcohol and glycerol monostearate;

(i) adsorbents, such as kaolin and bentonite; and (j) lubricants, such as talc, calcium stearate, magnesium stearate, solid polyethylene glycols, sodium lauryl sulfate, or mixtures thereof. For capsules, tablets, and pills, the dosage forms may also comprise buffering agents.

5 Liquid dosage forms for oral administration include pharmaceutically acceptable emulsions, solutions, suspensions, syrups, and elixirs. In addition to the active Harlil sequence compounds, the liquid dosage forms may comprise inert diluents commonly used in the art, such as water or other solvents, solubilizing agents, and emulsifiers. Exemplary emulsifiers are ethyl alcohol,
10 isopropyl alcohol, ethyl carbonate, ethyl acetate, benzyl alcohol, benzyl benzoate, propyleneglycol, 1,3-butyleneglycol, dimethylformamide, oils, such as cottonseed oil, groundnut oil, corn germ oil, olive oil, castor oil, and sesame oil, glycerol, tetrahydrofurfuryl alcohol, polyethyleneglycols, fatty acid esters of sorbitan, or mixtures of these substances, and the like. Besides such inert diluents, the
15 composition can also include adjuvants, such as wetting agents, emulsifying and suspending agents, sweetening, flavoring, and perfuming agents.

 Another method of administering the segment of NTP is by a transdermal or transcutaneous route. One example of such an embodiment is the use of a patch. In particular, a patch can be prepared with a fine suspension of segment of
20 NTP in, for example, dimethylsulfoxide (DMSO), or a mixture of DMSO with cottonseed oil and brought into contact with the skin of the mammals away from the treatment site. The composition may be present inside a skin pouch. Other mediums or mixtures thereof with other solvents and solid supports would work equally as well. The patch can contain the segment of NTP in the form of a
25 solution or a suspension. The patch can then be applied to the skin of the patient, for example, by means of inserting it into a skin pouch of the patient formed by folding and holding the skin together by means of stitches, clips or other holding devices. This pouch should be employed in such a manner so that continuous contact with the skin is assured without the interference of the mammal. Besides
30 using a skin pouch, any device can be used which ensures the firm placement of the patch in contact with the skin. For instance, an adhesive bandage could be

used to hold the patch in place on the skin.

Actual dosage levels of the active ingredients in the compositions of the invention may be varied to obtain a segment to NTP-containing composition that is effective in obtaining a desired tissue necrosis-inhibiting therapeutic response
5 for a particular composition and method of administration. The selected dosage level therefore depends upon the desired therapeutic effect, the route of administration, the desired duration of treatment, and other factors.

With mammals, including humans, the effective amounts can be administered on the basis of body surface area. The interrelationship of dosages
10 for animals of various sizes, species, and humans (based on mg/M^2 of body surface) is described by E. J. Freireich et al., *Cancer Chemother. Rep.*, 50(4):219 (1966). Body surface area may be approximately determined from the height and weight of an individual (*see e.g.*, Scientific Tables, Geigy Pharmaceuticals, Ardsley, N.Y. pp. 537-538 (1970)).

15 The total daily dose of the segment of NTP that is administered to a host may be in single or divided doses. Dosage unit compositions may contain such amounts of such submultiples thereof as may be used to make up the daily dose. It will be understood, however, that the specific dose level for any particular patient will depend upon a variety of factors including the body weight, general
20 health, sex, diet, time and route of administration, potency of the administered drug, rates of absorption and excretion, combination with other drugs and the severity of the particular disease being treated.

The segment of NTP-containing compositions of the present invention preferably contain a component that enables the segment of NTP to cross the
25 blood-brain barrier to treat live brain tissue. Any of the variety of components described above can be used to render the segments capable of crossing the blood-brain barrier. For example, the segments of NTP may be small enough to traverse the blood-brain barrier. In this case, no additional component would be required.

The segments of NTP thereof may be glycosylated to enhance the permeability
30 of the bbb, as disclosed in U.S. Pat. No. 5,260,308, or formed into a prodrug, as disclosed in U.S. Pat. No. 4,933,324 and WO 89/07938. These prodrugs

preferably are formed from a fatty acid carrier and an segment of NTP, which is unable to pass across the bbb on its own.

An alternative approach is the implantation of controlled release polymers that release the segments of NTP from a matrix-system directly into the nervous
5 tissue (see Sabel *et al.* U.S. Pat. No. 4,883,666; and Sabel *et al.* U.S. patent application Ser. No. 07/407,930.). It also is possible to use drug carrier systems such as liposomes, erythrocyte ghosts, antibody-conjugates, and monoclonal antibody conjugates. In accordance with this embodiment of the invention, so-called "stealth" lipids, such as phosphatidylinositol, monosialoganglioside, or
10 sulfogalactosylceramide can be used to form the liposomes containing the aforementioned antibodies and antibody conjugates.

The segments of NTP may be conjugated with an antibody that is reactive with a transferrin receptor, as disclosed in U.S. Pat. Nos. 5,182,107 and 5,154,924. Transferrin receptors are located on brain capillary endothelial cells,
15 which thus transport a drug, such as nerve growth factor, or segments of NTP, across the bbb. The segment of NTP-antibody conjugate described above can be further enhanced by providing cationized antibodies with a specific isoelectric point, as disclosed in U.S. Pat. No. 5,004,697 and WO 89/01343.

Another embodiment of the invention encompasses creating chimeric
20 peptides to which the active segments of NTP are conjugated, as disclosed in U.S. Pat. No. 4,801,575. The chimeric peptide preferably is histone, which is capable of crossing the bbb by transcytosis, as disclosed in U.S. Pat. No. 4,902,505. A further embodiment of the invention includes providing the segments of NTP together with the reduced, biooxidizable lipoidal form of a dihydropyridine
25 reaction-pyridine salt redox carrier such as dopamine, as disclosed in U.S. Pat. Nos. 4,880,816, 5,187,158, and 5,017,566.

Another approach also can be taken to deliver the segments of NTP to the brain. This can be done by chemically disrupting the bbb and then using viruses to deliver the segments of NTP across the bbb, as disclosed in U.S. Pat. No.
30 4,866,042. Here, it is preferred that a corrective genetic material is incorporated into a virus and the virus is then injected into the bloodstream. Yet another carrier

system that can be used to deliver the segments of NTP across the bbb is the use of liposomes, as disclosed by F. D. Collins and R. C. Thompson (WO 91/04014). Here, liposomes preferably are targeted to specific endogenous brain transport systems that transport specific ligands across the bbb. Surfactant coated
5 nanoparticles also can be used as a drug carrier (or targeting molecule) for the segments of NTP of the invention in order to enhance the penetration thereof across the bbb, as disclosed in U.S. Patent No. 6,117,454.

Another approach is to use L-amino acid oxidase to reduce the plasma level of the segments of NTP to allow transport of the segments of NTP across the
10 bbb. Such an approach is described in more detail in U.S. Patent No. 5,695,751, the disclosure of which is incorporated by reference herein in its entirety.

Another approach in accordance with the present invention is to administer compositions comprising the segments of NTP locally. Devices useful in administering compositions to an internal portion of the brain are described in, for
15 example, U.S. Patent No. 5,800,390, the disclosure of which is incorporated by reference herein in its entirety. Sustained release, solid preparations and semi-solid preparations can be administered directly to brain tissue. Such administration can be accomplished by inserting a needle-like member of such an intracerebral device that is optionally implanted in the head so that a distal end of
20 the guide is positioned at a site of administration.

A preferred composition of the present invention for administration to a mammal suffering from a condition associated with cell death and/or tissue necrosis contains the segments of NTP, and a component that enables the segments of NTP to cross the bbb. Other preferred compositions of the present
25 invention include a gene that expresses the segments of NTP and a component that enables the gene to cross the bbb. An additional preferred composition of the present invention includes a vaccine that induces expression of the segments of NTP and a component that enables the vaccine to cross the bbb.

It is preferred in the present invention that the amount of segments of NTP
30 that contacts the live tissue be an amount sufficient to inhibit, prevent, and/or ameliorate cell death and/or tissue necrosis. The specific amount can be

determined by those skilled in the art, using the guidelines provided herein. It is preferred that enough segments of NTP be administered to reduce cell death or tissue necrosis by more than 50%, when compared to a control where no segment of NTP is present and cell death goes unchecked. More preferably, the segments
5 of NTP are administered to reduce cell death or tissue necrosis by more than 60%, even more preferably by more than 70%, and most preferably by more than 75%, when compared to a control where no segment of NTP is present and cell death or tissue necrosis goes unchecked.

Such an amount will invariably depend on the particular type of tissue, the
10 segments of NTP used, as well as the amount of NTP or other molecular target. Using the methods disclosed in any of the aforementioned U.S. Patent Nos. 5,948,634, 5,948,888, 5,830,670, and 6,071,705, one can estimate the relative amount of NTP or other molecular target present, and then conduct a series of *in vitro* experiments using mammalian tissue obtained from various sources, such as
15 any of those disclosed in the aforementioned U.S. patents, determining the amount of NTP or other molecular target in the tissue, and then determining the requisite amount of segments of NTP that is required to obtain the requisite degree of cell death or tissue necrosis prevention (*i.e.*, preferably by more than 60% when compared to a control). Skilled artisans are capable of carrying out these
20 experiments using techniques known in the art, as well as using the guidelines provided herein.

The amount of segments of NTP to be administered to the mammal then can readily be determined based on the body weight of the mammal, and the expected delivery amount to the tissue. The amount of segments of NTP that will
25 be expected to be delivered to the brain tissue of a mammal will depend on the particular mechanism that is employed to render the segments of NTP capable of crossing the bbb. The same holds true for administration of genes that express the segments of NTP or for the administration of vaccines that induce expression or production of the segments of NTP. Again, those skilled in the art are capable of
30 determining the appropriate dose of gene, vaccine, segments of NTP to administer to a mammal using the techniques described in the aforementioned patents that are

incorporated by reference herein in their entirety, and by using the guidelines provided therein and herein.

The following examples are provided to illustrate the present invention. It should be understood, however, that the invention is not to be limited to the
5 specific conditions or details described in these examples.

Example 1

This example demonstrates cell death in live tissue (*in vivo*) due to the presence of AD7C-NTP.

AD7C-NTP was obtained in accordance with the procedures outlined in
10 any one of U.S. Patent Nos. 5,948,634, 5,948,888, 5,830,670, and 6,071,705.

Eight normal rats were injected in the skin and subcutaneously, each in 3 different foci, with purified recombinant AD7C-NTP in saline at concentrations of 0.1-1.0 µg/mL delivered from plastic syringes through stainless steel 26 gauge needles.

15 The animals were observed for 24 hours and painlessly sacrificed at 24 hours. The 24 individual foci of infiltration were excised, fixed in 10% formalin, embedded in paraffin, and stained and examined by standard histopathological methods.

Similar groups of control rats were injected with (1) bovine serum albumin
20 in saline, (2) normal human serum, and (3) physiological saline, and examined and sacrificed as above, with the excised foci of injection treated as above.

Injection of AD7C-NTP in all examples produced acute necrosis of tissue at the injection sites. The necrosis is evident in muscle tissue, subcutaneous connective tissue, and dermis at the sites where the AD7C-NTP was injected. At
25 24 hours, cells appear pale, shrunken, and necrotic, and there is infiltration with inflammatory cells. The necrosis correlates with the areas of injection and does not appear to spread far beyond the site of injection.

Controls showed no evidence of necrosis or cell loss. Control injections had mild to minimal acute inflammation and focal microhemorrhages from the
30 needles.

Example 2

The purpose of this example was to identify several Harlil sequences of the AD7C-NTP neural thread protein and determine their reactivity with AD7C-NTP.

- 5 The following Harlil sequences were synthesized (Synpep, Dublin CA) and conjugated to maleimide activated Rabbit IgG (Jackson ImmunoResearch, West Grove PA) and assessed for their NTP immunoreactivity. A linker was added, which was a repetition of the protein sequence occurring before and after the 90-96 H H A R L C L sequence of AD7C-NTP.

10	1.	(NTP-1)	L H A R L C L A N F C G R N R V
	2.	(NTP-2)	L A R L C L A N F C G N N N V
	3.	(NTP-3)	C A R Y R T G H H A R L M
	4.	(NTP-4)	H H A R L P L A N F C G
	5.	(NTP-5)	R T G H H A R L C L A N F C
15	6.	(NTP-6)	C E S A R Y R T G H H A R L C
	7.	(NTP-7)	D N T H H A R L I L
	8.	(NTP-8)	S H H A R L I L

- Conjugation to carrier proteins was through a cysteine. Thus, peptides NTP-1 and NTP-2 produced mixed conjugate results because there were more
 20 than one cysteine residue. Therefore, for peptides NTP-5 and NTP-6, the secondary cysteine was blocked with Acetamido Methyl (C_3H_6NO) (ACM).

- The location of the identified sequences in the AD7C-NTP sequence can be seen in Fig. 1. As mentioned above, homologues, derivatives, mimetics and variants of the Harlil peptides are also encompassed by the scope of the invention.
 25 For construction of the homologous peptides of this example, homologous amino acids were used. The substitution criteria used were charge and/or size. Thus, the choice to substitute methionine for cysteine in NTP peptide 3 was based on overall similarity between these two amino acids and the desire to remove a reactive cysteine from this particular stretch of amino acids. The choice to
 30 substitute proline for cysteine was an attempt to see if this would mimic the

conformational form of the peptide when it was in the protein and the cysteine was in disulfide linkage.

Other changes known to persons of skill in the art to affect or study affinity interactions include, but are not limited to, for example, interchanging
5 leucine with other hydrophobic amino acids, such as isoleucine, valine, alanine or glycine; interchanging acidic amino acids or basic amino acids; interchanging histidine with phenylalanine to determine the effect of charge vs spatial; interchanging asparagine with aspartic, or glutamine with glutamic, to evaluate the effect of charge vs spatial; and interchanging serine with threonine, threonine
10 with cysteine, aspartic with glutamic, arginine with lysine or histidine, and tyrosine with tryptophan or phenylalanine. The changes introduced to the flanking sequences were done to render the peptide less basic or hydrophobic

Example 3

This example demonstrates preventing and/or inhibiting necrosis of live
15 tissue (*in vivo*) by administering a segment of NTP or homologue, variant, mimetic or derivative thereof that binds NTP to tissue that contains NTP.

AD7C-NTP was obtained as described above in Example 1.

The Harlil sequences NTP-1, NTP-3, and NTP-7 prepared in accordance with Example 2 above were used in this example.

20 Recombinant AD7C-NTP samples 100 ng/mL-10 µg/mL were incubated at room temperature for 5 minutes to one hour with the aforementioned Harlil sequences and then injected into rats as described in Example 1.

Alternatively, a solution of the Harlil sequence was made up in concentrations ranging from 1 microgram/mL to 1 milligram/mL. Solutions
25 containing the recombinant AD7C-NTP also were made up as described above, without the addition of the Harlil sequence. The animals were injected with about 100 microliters of the AD7C-NTP solution, and with about 100 microliters of the Harlil solution.

The animals were observed for 24 hours and painlessly sacrificed at 24
30 hours. The 24 individual foci of infiltration were excised, fixed in 10% formalin,

embedded in paraffin, and stained and examined by standard histopathological methods.

Similar groups of control rats were injected with (1) AD7C-NTP alone as described in Example 1, (2) bovine serum albumin in saline, (3) normal human serum, and (4) physiological saline, and examined and sacrificed as above, with the excised foci of injection treated as above.

The control injections of AD7C-NTP alone produced tissue necrosis, as described in Example 1. Control injections of bovine serum albumin (BSA), normal human serum, and physiological saline all showed no evidence of necrosis or cell loss. The above control injections had mild to minimal acute inflammation and focal microhemorrhages from the needles.

The AD7C-NTP samples that were injected together with each of the Harlil sequences NTP-1, NTP-3, and NTP-7 showed over 95% reduction in tissue necrosis, when compared to the control samples injected with AD7C-NTP alone. There were occasional focal nodules of inflammatory cell foci with micronodule formation which appeared to possibly be aggregation of AD7C-NTP and the Harlil sequence. The overall tissue injury was reduced by >95% by administration of the segment of NTP (or Harlil sequence), when compared to controls that were injected only with AD7C-NTP.

While the invention has been described in detail with reference to particularly preferred embodiments and examples, those skilled in the art will appreciate that various modifications may be made to the invention without departing from the spirit and scope thereof.

What is claimed is:

1) A method of preventing and/or inhibiting cell death and/or tissue necrosis in live tissue comprising contacting the live tissue with at least one segment of NTP, whereby the segment of NTP is present in an amount sufficient to prevent and/or inhibit cell death and/or tissue necrosis.

2) The method of claim 1 wherein at least one segment of NTP contains an amino acid sequence selected from the group consisting of:

- a) THARLIL; HHARLCL; MFARLIL; HHARLIF;
- b) HHARL; HARL; HARLI; HARLIL; HHARLCL; ARLIL; HHARLIF; THARLIL; ARLI; ARL; HARLCL; ARLCL; ARCL; MFARLIL; FARLIL; FARLI; FARL; HARLIF; ARLIF;
- c) LHARLCLANFCGRNRV;
- d) LARLCLANFCGNNNV;
- e) CARYRTGHHARLM;
- f) HHARLPLANFCG;
- g) RTGHHARLCLANFC;
- h) CESARYRTGHHARLC;
- i) DNTHHARLIL;
- j) SHHARLIL; and
- k) HARLML; HARLVL; and HAKLIL

and variants, homologues, derivatives, and mimetics thereof.

3) A method of treating conditions associated with cell death and/or tissue necrosis, comprising contacting live tissue with at least one segment of NTP, whereby the segment of NTP is present in an amount sufficient to prevent and/or inhibit cell death and/or tissue necrosis.

4) The method of claim 3 wherein at least one segment of NTP contains an amino acid sequence selected from the group consisting of :

- a) THARLIL; HHARLCL; MFARLIL; HHARLIF;
- b) HHARL; HARL; HARLI; HARLIL; HHARLCL; ARLIL; HHARLIF; THARLIL; ARLI; ARL; HARLCL; ARLCL; ARCL; MFARLIL; FARLIL; FARLI; FARL; HARLIF; ARLIF;
- c) LHARLCLANFCGRNRV;
- d) LARLCLANFCGNNNV;
- e) CARYRTGHHARLM;
- f) HHARLPLANFCG;
- g) RTGHHARLCLANFC;
- h) CESARYRTGHHARLC;
- i) DNTHHARLIL;
- l) SHHARLIL; and
- m) HARLML; HARLVL; and HAKLIL

and variants, homologues, derivatives, and mimetics thereof.

5) A method of preventing and/or inhibiting cell death and/or tissue necrosis in live mammalian brain tissue by contacting the live mammalian brain tissue with a composition containing at least a segment of NTP, whereby the composition further comprises a component that enables the segment of NTP to cross the blood-brain barrier.

6) The method of claim 5 wherein at least one segment of NTP contains an amino acid sequence selected from the group consisting of :

- a) THARLIL; HHARLCL; MFARLIL; HHARLIF;
- b) HHARL; HARL; HARLI; HARLIL; HHARLCL; ARLIL; HHARLIF; THARLIL; ARLI; ARL; HARLCL; ARLCL; ARCL; MFARLIL; FARLIL; FARLI; FARL; HARLIF; ARLIF;
- c) LHARLCLANFCGRNRV;
- d) LARLCLANFCGNNNV;

- e) CARYRTGHHARLM;
- f) HHARLPLANFCG;
- g) RTGHHARLCLANFC;
- h) CESARYRTGHHARLC;
- i) DNTHHARLIL;
- n) SHHARLIL; and
- o) HARLML; HARLV L; and HAKLIL

and variants, homologues, derivatives, and mimetics thereof.

7) A method of treating a neurodegenerative disorder by contacting live mammalian brain tissue with a composition containing at least a segment of NTP, whereby the composition further comprises a component that enables the segment of NTP to cross the blood-brain barrier.

8) The method of claim 7 wherein at least one segment of NTP contains an amino acid sequence selected from the group consisting of :

- a) THARLIL; HHARLCL; MFARLIL; HHARLIF;
- b) HHARL; HARL; HARLI; HARLIL; HHARLCL; ARLIL; HHARLIF; THARLIL; ARLI; ARL; HARLCL; ARLCL; ARCL; MFARLIL; FARLIL; FARLI; FARL; HARLIF; ARLIF;
- c) LHARLCLANFCGRNRV;
- d) LARLCLANFCGNNNV;
- e) CARYRTGHHARLM;
- f) HHARLPLANFCG;
- g) RTGHHARLCLANFC;
- h) CESARYRTGHHARLC;
- i) DNTHHARLIL;
- p) SHHARLIL; and
- q) HARLML; HARLV L; and HAKLIL

and variants, homologues, derivatives, and mimetics thereof.

9) The method of claim 7 wherein the neurodegenerative disorder is Alzheimer's disease.

10) The method of claim 8 wherein the neurodegenerative disorder is Alzheimer's disease.

11) A composition for treating conditions associated with cell death and/or tissue necrosis comprising a segment of NTP and a component that enables the segment of NTP to cross the blood-brain barrier.

12) The method of claim 11 wherein at least one segment of NTP contains an amino acid sequence selected from the group consisting of :

- a) THARLIL; HHARLCL; MFARLIL; HHARLIF;
- b) HHARL; HARL; HARLI; HARLIL; HHARLCL; ARLIL; HHARLIF; THARLIL; ARLI; ARL; HARLCL; ARLCL; ARCL; MFARLIL; FARLIL; FARLI; FARL; HARLIF; ARLIF;
- c) L HARLCLANFCGRNRV;
- d) LARLCLANFCGNNNV;
- e) CARYRTGHHARLM;
- f) HHARLPLANFCG;
- g) RTGHHARLCLANFC;
- h) CESARYRTGHHARLC;
- i) DNTHHARLIL;
- r) SHHARLIL; and
- s) HARLML; HARLVL; and HAKLIL

and variants, homologues, derivatives, and mimetics thereof.

13) A method of preventing, modulating, controlling, ameliorating and/or inhibiting cell death and/or tissue necrosis in live tissue at or near the site where

NTP has been administered for therapeutic purposes, comprising contacting the live tissue with at least one segment of NTP, whereby the segment of NTP is present in an amount sufficient to prevent, modulate, control, ameliorate and/or inhibit cell death and/or tissue necrosis caused by the therapeutic administration of NTP.

14) The method of claim 13 wherein at least one segment of NTP contains an amino acid sequence selected from the group consisting of :

- a) THARLIL; HHARLCL; MFARLIL; HHARLIF;
- b) HHARL; HARL; HARLI; HARLIL; HHARLCL; ARLIL; HHARLIF; THARLIL; ARLI; ARL; HARLCL; ARLCL; ARCL; MFARLIL; FARLIL; FARLI; FARL; HARLIF; ARLIF;
- c) LHARLCLANFCGRNRV;
- d) LARLCLANFCGNNNV;
- e) CARYRTGHHARLM;
- f) HHARLPLANFCG;
- g) RTGHHARLCLANFC;
- h) CESARYRTGHHARLC;
- i) DNTHHARLIL;
- t) SHHARLIL; and
- u) HARLML; HARLVL; and HAKLIL

and variants, homologues, derivatives, and mimetics thereof.

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Figure 1

1	tttttttttttggag	ATG GAG TTT TCG CTC TTG TTG CCC AGG CTG GAG TGC AAT GGC GCA ATC	62
1		M E F S L L L P R L E C N G A I	16
63	TCA GCT CAC CGC AAC CTC CGC CTC CCG GGT TCA AGC GAT TCT CCT GCC TCA GCC TCC CCA	122	
17	S A H R N L R L P G S S D S P A S A S P	36	
123	GTA GCT GGG ATT ACA GGC ATG TGC ACC CAC GCT CGG CTA ATT TTG TAT TTT TTT TTA GTA	182	
37	V A G I T G M C T H A R L I L Y F F L V	56	
183	GAG ATG GAG TTT CTC CAT GTT GGT CAG GCT GGT CTC GAA CTC CCG ACC TCA GAT GAT CCC	242	
57	E M E F L H V G Q A G L E L P T S D D P	76	
243	TCC GTC TCG GCC TCC CAA AGT GCT AGA TAC AGG ACT GGC CAC CAT GCC CGG CTC TGC CTG	302	
77	S V S A S Q S A R Y R T G H H A R L C L	96	
303	GCT AAT TTT TGT GGT AGA AAC AGG GTT TCA CTG ATG TGC CCA AGC TGG TCT CCT GAG CTC	362	
97	A N F C G R N R V S L M C P S W S P E L	116	
363	AAG CAG TCC ACC TGC CTC AGC CTC CCA AAG TGC TGG GAT TAC AGG CGT GCA GCC GTG CCT	422	
117	K Q S T C L S L P K C W D Y R R A A V P	136	
423	GGC CTT TTT ATT TTA TTT TTT TTA AGA CAC AGG TGT CCC ACT CTT ACC CAG GAT GAA GTG	482	
137	G L F I L F F L R H R C P T L T Q D E V	156	
483	CAG TGG TGT GAT CAC AGC TCA CTG CAG CCT TCA ACT CCT GAG ATC AAG CAT CCT CCT GCC	542	
157	Q W C D H S S L Q P S T P E I K H P P A	176	
543	TCA GCC TCC CAA GTA GCT GGG ACC AAA GAC ATG CAC CAC TAC ACC TGG CTA ATT TTT ATT	602	
177	S A S Q V A G T K D M H H Y T W L I F I	196	
603	TTT ATT TTT AAT TTT TTG AGA CAG AGT CTC AAC TCT GTC ACC CAG GCT GGA GTG CAG TGG	662	
197	F I F N F L R Q S L N S V T Q A G V Q W	216	
663	CGC AAT CTT GGC TCA CTG CAA CCT CTG CCT CCC GGG TTC AAG TTA TTC TCC TGC CCC AGC	722	
217	R N L G S L Q P L P P G F K L F S C P S	236	
723	CTC CTG AGT AGC TGG GAC TAC AGG CGC CCA CCA CGC CTA GCT AAT TTT TTT GTA TTT TTA	782	
237	L L S S W D Y R R P P R L A N F F V F L	256	
783	GTA GAG ATG GGG TTC ACC ATG TTC GCC AGG TTG ATC TTG ATC TCT GGA CCT TGT GAT CTG	842	
257	V E M G F T M F A R L I L I S G P C D L	276	
843	CCT GCC TCG GCC TCC CAA AGT GCT GGG ATT ACA GGC GTG AGC CAC CAC GCC CGG CTT ATT	902	
277	P A S A S Q S A G I T G V S H H A R L I	296	
903	TTT AAT TTT TGT TTG TTT GAA ATG GAA TCT CAC TCT GTT ACC CAG GCT GGA GTG CAA TGG	962	
297	F N F C L F E M E S H S V T Q A G V Q W	316	
963	CCA AAT CTC GGC TCA CTG CAA CCT CTG CCT CCC GGG CTC AAG CGA TTC TCC TGT CTC AGC	1022	
317	P N L G S L Q P L P P G L K R F S C L S	336	
1023	CTC CCA AGC AGC TGG GAT TAC GGG CAC CTG CCA CCA CAC CCC GCT AAT TTT TGT ATT TTC	1082	
337	L P S S W D Y G H L P P H P A N F C I F	356	
1083	ATT AGA GGC GGG GTT TCA CCA TAT TTG TCA GGC TGG TCT CAA ACT CCT GAC CTC AGG tgac	1143	
357	I R G G V S P Y L S G W S Q T P D L R	375	
1144	ccacctgcctcagccttccaaagtgcgtgggattacaggcgtagccacctcaccagccgggctaatttagataaaaaaat	1223	
1224	atgtagcaatgggggggtcttgctatgttgccaggctgggtctcaaacttctggcttcatgcaatccttccaaatgagcca	1303	
1304	caacacccagccagtcacattttttaaacagttacatctttatttttagtatactagaaagtaataacaataaacatgtcaa	1383	
1384	acctgcaaattcagtagtaacagagttcttttataacttttaacaaagcttttagagca	1442	

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Figure 2

NTP[122]

1 Met-Met-Val-Cys-Trp-Asn-Arg-Phe-Gly-Lys-
M M V C W N R F G K

11 Trp-Val-Tyr-Phe-Ile-Ser-Ala-Ile-Phe-Asn-
W V Y F I S A I F N

21 Phe-Gly-Pro-Arg-Tyr-Leu-Tyr-His-Gly-Val-
F G P R Y L Y H G V

31 Pro-Phe-Tyr-Phe-Leu-Ile-Leu-Val-Arg-Ile-
P F Y F L I L V R I

41 Ile-Ser-Phe-Leu-Ile-Gly-Asp-Met-Glu-Asp-
I S F L I G D M E D

51 Val-Leu-Leu-Asn-Cys-Thr-Leu-Leu-Lys-Arg-
V L L N C T L L K R

61 Ser-Ser-Arg-Phe-Arg-Phe-Trp-Gly-Ala-Leu-
S S R F R F W G A L

71 Val-Cys-Ser-Met-Asp-Ser-Cys-Arg-Phe-Ser
V C S M D S C R F S

81 Arg-Val-Ala-Val-Thr-Tyr-Arg-Phe-Ile-Thr-
R V A V T Y R F I T

91 Leu-Leu-Asn-Ile-Pro-Ser-Pro-Ala-Val-Trp-
L L N I P S P A V W

101 Met-Ala-Arg-Asn-Thr-Ile-Asp-Gln-Gln-Val-
M A R N T I D Q Q V

111 Leu-Ser-Arg-Ile-Lys-Leu-Glu-Ile-Lys-Arg-
L S R I K L E I K R

121 Cys-Leu
C L

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Figure 3

NTP[112]

```
1   Met-Ala-Gln-Ser-Arg-Leu-Thr-Ala-The-Ser-
    M  A  Q  S  R  L  T  A  T  S

11  Ala-Ser-Arg-Val-Gln-Ala-Ile-Leu-Leu-Ser-
    A  S  R  V  Q  A  I  L  L  S

21  Gln-Pro-Pro-Lys-Gln-Leu-Gly-Leu-Arg-Ala-
    Q  P  P  K  Q  L  G  L  R  A

31  Pro-Ala-Asn-Thr-Pro-Leu-Ile-Phe-Val-Phe-
    P  A  N  T  P  L  I  F  V  F

41  Ser-Leu-Glu-Ala-Gly-Phe-His-His-Ile-Cys-
    S  L  E  A  G  F  H  H  I  C

51  Gln-Ala-Gly-Leu-Lys-Leu-Leu-Thr-Ser-Gly-
    Q  A  G  L  K  L  L  T  S  G

61  Asp-Pro-Pro-Ala-Ser-Ala-Phe-Gln-Ser-Ala-
    D  P  P  A  S  A  F  Q  S  A

71  Gly-Ile-Thr-Gly-Val-Ser-His-Leu-Thr-Gln-
    G  I  T  G  V  S  H  L  T  Q

81  Pro-Ala-Asn-Leu-Asp-Lys-Lys-Ile-Cys-Ser-
    P  A  N  L  D  K  K  I  C  S

91  Asn-Gly-Gly-Ser-Cys-Tyr-Val-Ala-Gln-Ala-
    N  G  G  S  C  Y  V  A  Q  A

101 Gly-Leu-Lys-Leu-Leu-Ala-Ser-Cys-Asn-Pro-
    G  L  K  L  L  A  S  C  N  P

111 Ser-Lys
    S  K
```

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Figure 4

NTP[106]

```
1   Met-Trp-Thr-Leu-Lys-Ser-Ser-Leu-Val-Leu-  
    M   W   T   L   K   S   S   L   V   L  
  
11  Leu-Leu-Cys-Leu-Thr-Cys-Ser-Tyr-Ala-Phe-  
    L   L   C   L   T   C   S   Y   A   F  
  
21  Met-Phe-Ser-Ser-Leu-Arg-Gln-Lys-Thr-Ser-  
    M   F   S   S   L   R   Q   K   T   S  
  
31  Glu-Pro-Gln-Gly-Lys-Val-Pro-Cys-Gly-Glu-  
    E   P   Q   G   K   V   P   C   G   E  
  
41  His-Phe-Arg-Ile-Arg-Gln-Asn-Leu-Pro-Glu-  
    H   F   R   I   R   Q   N   L   P   E  
  
51  His-Thr-Gln-Gly-Trp-Leu-Gly-Ser-Lys-Trp-  
    H   T   Q   G   W   L   G   S   K   W  
  
61  Leu-Trp-Leu-Leu-Phe-Ala-Val-Val-Pro-Phe-  
    L   W   L   L   F   A   V   V   P   F  
  
71  Val-Ile-Leu-Lys-Cys-Gln-Arg-Asp-Ser-Glu-  
    V   I   L   K   C   Q   R   D   S   E  
  
81  Lys-Asn-Lys-Val-Arg-Met-Ala-Pro-Phe-Phe-  
    K   N   K   V   R   M   A   P   F   F  
  
91  Leu-His-His-Ile-Asp-Ser-Ile-Ser-Gly-Val-  
    L   H   H   I   D   S   I   S   G   V  
  
101 Ser-Gly-Lys-Arg-Met-Phe  
    S   G   K   R   M   F
```

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Figure 5

NTP [106]

```
1   Met-Phe-Phe-Val-Leu-Tyr-Arg-Phe-Cys-Phe-
    M   F   F   V   L   Y   R   F   C   F

11  Cys-Phe-Phe-Glu-Thr-Glu-Ser-His-Ser-Leu-
    C   F   F   E   T   E   S   H   S   L

21  Thr-Gln-Ala-Gly-Val-Gln-Trp-Cys-Glu-Leu-
    T   Q   A   G   V   Q   W   C   E   L

31  Gly-Ser-Pro-Gln-Pro-Leu-Pro-Ser-Gly-Phe-
    G   S   P   Q   P   L   P   S   G   F

41  Lys-Arg-Phe-Ser-Cys-Leu-Ser-Leu-Leu-Ser-
    K   R   F   S   C   L   S   L   L   S

51  Ser-Trp-Asp-Tyr-Ser-His-Glu-Pro-Pro-His-
    S   W   D   Y   S   H   E   P   P   H

61  Pro-Val-Ile-Cys-Ser-Phe-Leu-Met-Glu-Lys-
    P   V   I   C   S   F   L   M   E   K

71  Cys-Leu-Ile-Leu-Tyr-Lys-Pro-Asn-Gly-Asp-
    C   L   I   L   Y   K   P   N   G   D

81  Thr-Ile-Gly-Pro-Ile-Leu-Val-Gln-Gln-Gly-
    T   I   G   P   I   L   V   Q   Q   G

91  Lys-Arg-Gln-Lys-Leu-Tyr-Ile-Ser-Ala-Asp-
    K   R   Q   K   L   Y   I   S   A   D

100 Leu-Val-His-Leu-Ile-Ala
    L   V   H   L   I   A
```


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Figure 6

NTP[98]

1 Glu-Ala-Tyr-Tyr-Thr-Met-Leu-His-Leu-Pro-
 E A Y Y T M L H L P

11 Thr-Thr-Asn-Arg-Pro-Lys-Ile-Ala-His-Cys
 T T N R P K I A H C

21 Ile-Leu-Phe-Asn-Gln-Pro-His-Ser-Pro-Arg-
 I L F N Q P H S P R

31 Ser-Asn-Ser-His-Ser-His-Pro-Asn-Pro-Leu-
 S N S H S H P N P L

41 Lys-Leu-His-Arg-Arg-Ser-His-Ser-His-Asn-
 K L H R R S H S H N

51 Arg-Pro-Arg-Ala-Tyr-Ile-Leu-Ile-Thr-Ile-
 R P R A Y I L I T I

61 Leu-Pro-Ser-Lys-Leu-Lys-Leu-Arg-Thr-His-
 L P S K L K L R T H

71 Ser-Gln-Ser-His-His-Asn-Pro-Leu-Ser-Arg-
 S Q S H H N P L S R

81 Thr-Ser-Asn-Ser-Thr-Pro-Thr-Asn-Ser-Phe-
 T S N S T P T N S F

91 Leu-Met-Thr-Ser-Ser-Lys-Pro-Arg
 L M T S S K P R

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Figure 7

NTP[75]

```
1   Ser-Ser-Ser-Leu-Gly-Leu-Pro-Lys-Cys-Trp-
    S   S   S   L   G   L   P   K   C   W

11  Asp-Tyr-Arg-His-Glu-Leu-Leu-Ser-Leu-Ala-
    D   Y   R   H   E   L   L   S   L   A

21  Leu-Met-Ile-Asn-Phe-Arg-Val-Met-Ala-Cys
    L   M   I   N   F   R   V   M   A   C

31  Thr-Phe-Lys-Gln-His-Ile-Glu-Leu-Arg-Gln-
    T   F   K   Q   H   I   E   L   R   Q

41  Lys-Ile-Ser-Ile-Val-Pro-Arg-Lys-Leu-Cys-
    K   I   S   I   V   P   R   K   L   C

51  Cys-Met-Gly-Pro-Val-Cys-Pro-Val-Lys-Ile-
    C   M   G   P   V   C   P   V   K   I

61  Ala-Leu-Leu-Thr-Ile-Asn-Gly-His-Cys-Thr-
    A   L   L   T   I   N   G   H   C   T

71  Trp-Leu-Pro-Ala-Ser
    W   L   P   A   S
```

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Figure 8

NTP[68]

```
1   Met-Phe-Val-Phe-Cys-Leu-Ile-Leu-Asn-Arg-  
    M   F   V   F   C   L   I   L   N   R  
  
11  Glu-Lys-Ile-Lys-Gly-Gly-Asn-Ser-Ser-Phe-  
    E   K   I   K   G   G   N   S   S   F  
  
21  Phe-Leu-Leu-Ser-Phe-Phe-Phe-Ser-Phe-Gln-  
    F   L   L   S   F   F   F   S   F   Q  
  
31  Asn-Cys-Cys-Gln-Cys-Phe-Gln-Cys-Arg-Thr-  
    N   C   C   Q   C   F   Q   C   R   T  
  
41  Thr-Glu-Gly-Tyr-Ala-Val-Glu-Cys-Phe-Tyr-  
    T   E   G   Y   A   V   E   C   F   Y  
  
51  Cys-Leu-Val-Asp-Lys-Ala-Ala-Phe-Glu-Cys-  
    C   L   V   D   K   A   A   F   E   C  
  
61  Trp-Trp-Phe-Tyr-Ser-Phe-Asp-Thr  
    W   W   F   Y   S   F   D   T
```

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Figure 9

NTP[61]

```
1   Met-Glu-Pro-His-Thr-Val-Ala-Gln-Ala-Gly-
    M   E   P   H   T   V   A   Q   A   G

11  Val-Pro-Gln-His-Asp-Leu-Gly-Ser-Leu-Gln-
    V   P   Q   H   D   L   G   S   L   Q

21  Ser-Leu-Leu-Pro-Arg-Phe-Lys-Arg-Phe-Ser-
    S   L   L   P   R   F   K   R   F   S

31  Cys-Leu-Ile-Leu-Pro-Lys-Ile-Trp-Asp-Tyr-
    C   L   I   L   P   K   I   W   D   Y

41  Arg-Asn-Met-Asn-Thr-Ala-Leu-Ile-Lys-Arg-
    R   N   M   N   T   A   L   I   K   R

51  Asn-Arg-Tyr-Thr-Pro-Glu-Thr-Gly-Arg-Lys-
    N   R   Y   T   P   E   T   G   R   K

61  Ser
    S
```